

**Compound for photoactive organic electronic components and
photoactive organic electronic component containing the compound**

Field of the invention

The invention relates to a compound suitable, for example, for use in
5 photoactive organic electronic components, and to a photoactive
organic electronic component comprising the compound. The invention
additionally relates to a process for preparing said compound.

State of the art

Photoactive organic electronic components enable conversion of
10 electromagnetic radiation, for instance in the wavelength range of
visible light, to electrical current with exploitation of the
photoelectric effect. The conversion requires organic semiconductor
materials that exhibit sufficiently good absorption properties.

Technical object

15 It is consequently an object of the present invention to specify
organic compounds that exhibit good absorption properties and are
suitable, for example, for use in photoactive organic electronic
components.

The present invention relates not only to the compound of the
20 invention but additionally to the use of the compound of the
invention in a photoactive organic electronic component.

The present invention also relates to a photoactive organic
electronic component comprising the compound according to the
invention.

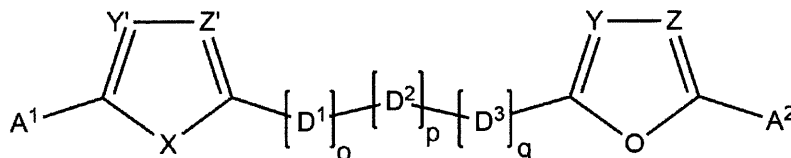
25 The invention additionally relates to a compound - as intermediate -
for the preparation of the compound of the invention.

The invention further relates to a process for preparing the compound
of the invention.

30 **Technical achievement of object**

The first object is achieved by a compound as claimed in claim 1.

Accordingly, the present invention relates to a compound of the general formula (I):



Y, Y', Z and Z' here are each independently selected from: N or CR^a.

5 "Independently selected" in this context also means that R^a can be different in each case for Y, Y', Z and Z'. However, it is also possible, for example, that R^a is the same for two, more than two or all of Y, Y', Z and Z'.

In the compound of the invention, X is selected from: O, S, Se,
10 Si(R^bR^c), P(R^b), P(O)R^b.

The R^a to R^c radicals are each independently selected from the group of the following radicals:

- H,
- halogen,
- 15 - CN,
- NR^dR^e where R^d and R^e are each independently selected from the group of the radicals: H and cyclic or open-chain C₁-C₂₀-alkyl, where individual carbon atoms may be replaced by heteroatoms and where hydrogen atoms in the alkyl radical may be substituted,
- 20 - cyclic or open-chain C₁-C₂₀-alkyl, where individual carbon atoms may be replaced by heteroatoms,
- cyclic or open-chain C₁-C₂₀-O-alkyl,
- cyclic or open-chain C₁-C₂₀-S-alkyl
- cyclic or open-chain C₂-C₂₀-alkenyl,
- 25 - cyclic or open-chain C₂-C₂₀-O-alkenyl,
- cyclic or open-chain C₂-C₂₀-S-alkenyl,
- cyclic or open-chain C₂-C₂₀-alkynyl,
- aryl,
- heteroaryl,

where hydrogen atoms in the alkyl, O-alkyl, S-alkyl, alkenyl, O-alkenyl, S-alkenyl, alkynyl, aryl and heteroaryl radicals may each independently be substituted.

Substitution is understood here and hereinafter to mean the replacement of one or more hydrogen atoms by other radicals. For example, hydrogen atoms may be replaced by halogen atoms, for instance fluorine atoms. For example, hydrogen atoms may alternatively be substituted by cyclic or open-chain alkyl radicals, for instance C₁-C₁₀-, preferably C₁-C₆-alkyl radicals, especially methyl, ethyl, propyl, butyl, pentyl, hexyl and the like, each of which may be linear or branched, and where the alkyl radicals may be at least partly halogenated, for example fluorinated, preferably perfluorinated.

Halogen in connection with the compound of the invention is understood here and hereinafter to mean in each case F, Cl, Br and I, preferably in each case F.

-CN is a nitrile group.

NR^dR^e is an amine function, which may be a primary, secondary or tertiary amine. R^d and R^e include linear and branched radicals alike. R^d and R^e may also be C₁-C₂₀-alkyl radicals in which hydrogen atoms are substituted. For example, hydrogen atoms may be replaced by fluorine atoms. R^d and R^e may additionally also be C₁-C₂₀-alkyl radicals where individual carbon atoms may be replaced by heteroatoms. This means more particularly that non-terminal, non-adjacent carbon atoms may be replaced by atoms such O, S, Se or an NR group where R is H or an alkyl. However, it is preferable that none of the carbon atoms in the C₁-C₂₀-alkyl radical is replaced by heteroatoms. Preferably, R^d and R^e are selected from H and C₁-C₁₀-alkyl radicals, especially from H, methyl, ethyl, propyl, butyl and pentyl.

The term "cyclic or open-chain C₁-C₂₀-alkyl" used for the R^a to R^c radicals in each case includes linear and branched C₁-C₂₀-alkyl radicals. This may include C₁-C₂₀-alkyl radicals where individual carbon atoms may be replaced by heteroatoms. This means more particularly that non-terminal, non-adjacent carbon atoms may be replaced by atoms such as O, S, Se or an NR group where R is H or an

alkyl. However, it is preferable that none of the carbon atoms in the C₁-C₂₀-alkyl radical is replaced by heteroatoms. For example, the radicals may be cyclic or open-chain C₁-C₁₀-alkyl radicals. More particularly, they may be open chain C₁-C₅-alkyl radicals.

- 5 For the cyclic or open-chain C₁-C₂₀-O-alkyl, cyclic or open-chain C₁-C₂₀-S-alkyl, cyclic or open-chain C₂-C₂₀-alkenyl, cyclic or open-chain C₂-C₂₀-O-alkenyl, cyclic or open-chain C₂-C₂₀-S-alkenyl and cyclic or open-chain C₂-C₂₀-alkynyl radicals too, the radicals in each case may be linear or branched.
- 10 For the cyclic or open-chain C₁-C₂₀-O-alkyl and for the cyclic or open-chain C₂-C₂₀-O-alkenyl, the oxygen in each case is the connection site to the compound of the invention.

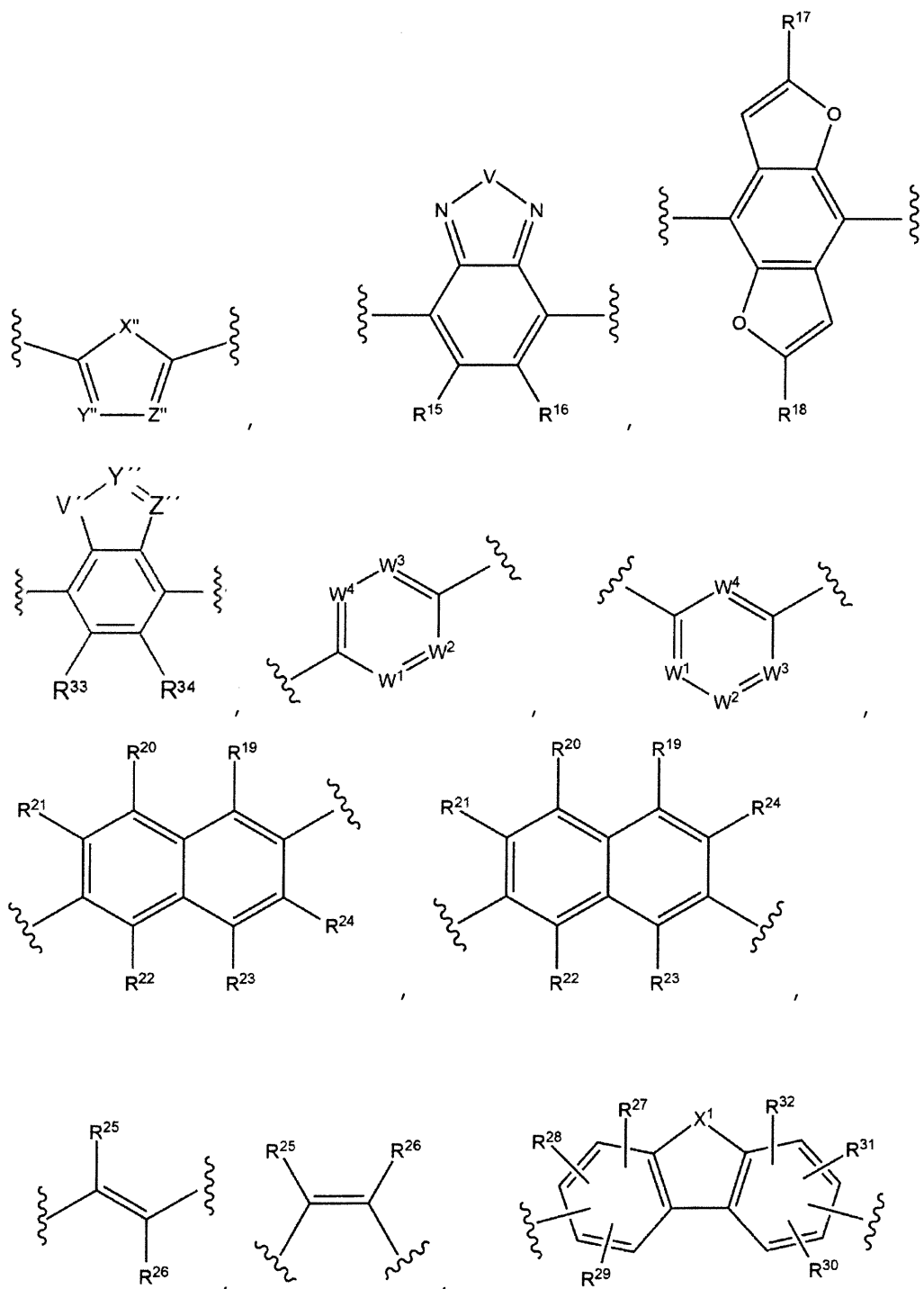
Analogously, for the cyclic or open-chain C₂-C₂₀-S-alkyl and for the cyclic or open-chain C₂-C₂₀-S-alkenyl, the sulfur in each case is the connection site to the compound of the invention.

Aryl in the case of the present invention is preferably understood to mean a C₅-C₂₀-aryl, for instance a C₅-C₁₂-aryl. A heteroaryl in the context of the present invention is understood to mean an aryl, where at least one carbon atom in the aryl in each case is replaced by a heteroatom. The heteroatom may, for example, be O, S, Se, Si, B, N or P.

In the compound of the invention, A¹ is an electron-withdrawing radical having at least one C=C double bond. In addition, A² is an electron-withdrawing radical having at least two conjugated C=C double bonds. For example, A¹ has one, two or three C=C double bonds that may be conjugated to one another. For example, A² has two or three conjugated C=C double bonds. In the case of A¹ here, the at least one C=C double bond is preferably not part of an aromatic ring. It is likewise the case for A² that the at least two conjugated C=C double bonds are preferably not part of an aromatic ring.

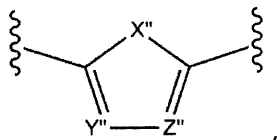
The A¹ and A² groups are thus each notable for their electron-withdrawing character and especially act as acceptor groups.

In the compound of the invention, the conjugated D¹, D² and D³ blocks are each independently selected from the group of the following structural units:



Independently selected means here that the individual conjugated D¹,
 10 D² and D³ blocks may each be identical or different structural units
 from those specified. It is also possible that two or more of the

conjugated D^1 to D^3 blocks can have the same base structure, for example



in which case, however, X'' , Y'' and Z'' for the different conjugated blocks must not be the same, but must be different. This means that it is possible, for example, that D^1 is a furan and D^2 a thiophene. It is also possible, for example, that both D^1 and D^2 are a thiophene, but the two thiophenes have different radicals. The examples just mentioned serve merely for illustration and should not be interpreted in a limiting manner.

The coefficients o and q each independently assume the values of 0 and 1 for the compound of the invention. The coefficient p assumes the values of 0, 1, 2, 3, 4 and 5. However, this is subject to the proviso that at least one of the three coefficients o , p and q must be non-zero. This means that at least one of the three conjugated D^1 to D^3 blocks must be present.

However, it is also possible, for example, for two or more of the conjugated D^1 to D^3 blocks to be present.

The structural units mentioned are as follows:

- Y'' is selected from: N or CR^g ;
- Z'' is selected from: N or CR^h ;
- X'' is selected from: O, S, Se, $Si(R^iR^j)$, $P(R^i)$, $P(O)R^i$;
- V is selected from: O, S, Se or NR^k ;
- V' is selected from: O, S, Se or NR^k ; preferably NR^k ,
- $X1$ is selected from: NR^l , CR^lR^m ;
- W^1 to W^4 are independently selected from: N, CR^n ;

where the R^g to R^n radicals and the R^{15} to R^{34} radicals are each independently selected from the group of the radicals as R^a to R^c . In addition, the R^g and R^h radicals may be joined to one another in the form of a ring structure. Moreover, an aryl radical may be fused to said ring structure. It is possible here that the latter aryl radical is substituted.

The ring structure may, for example, be a five-, six- or seven-membered ring. For example, it may be a saturated ring. For example, the ring may have heteroatoms, for instance O or S. Alternatively, it is possible that the ring is a homocyclic ring. For example, the ring
 5 may be substituted. For example, the ring may have fluorine atoms or alkyl groups as substituents. The ring may also have at least partly fluorinated alkyl groups as substituents.

The aryl radical which may be fused onto the ring structure may, for example, be a benzene ring having two carbon atoms in common with the
 10 ring structure.

The conjugated D¹ to D³ blocks together with the two five-membered rings that surround them, together with the two electron-withdrawing A¹ and A² groups, form a significant π electron system.

Advantages of the compound

15 Whether an organic compound is suitable for use in photoactive organic electronic components depends upon factors including the absorption characteristics of the compound. High absorption is desirable. More particularly, it is advantageous when the compound absorbs within a broad range of the available spectrum of
 20 electromagnetic radiation, since photons of a wide variety of different wavelengths can thus be utilized for the generation of electrical power.

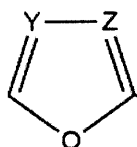
Specifically in the region of wavelengths less than 600 nm - especially less than 500 nm - the absorption of many organic
 25 compounds conventionally used in photoactive organic electronic components is inadequate. The effect of this is that the photons in this wavelength range cannot be utilized to a sufficient degree.

By contrast, the inventors of the present invention have found that the inventive compounds of the general formula (I) exhibit
 30 astonishingly good absorption characteristics within a comparatively broad range of visible light (about 400 to 700 nm). More particularly, a surprisingly high absorption in the short-wave solar spectral range from about 400 to 600 nm was found. Particularly for the wavelength range below 500 nm, distinctly better absorption

characteristics were observed than is the case for many compounds conventionally used in photoactive organic electronic components.

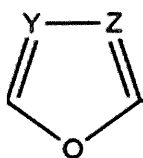
The inventors of the present invention have recognized that compounds of the general structure of formula (I) have molecular orbitals
 5 having an energy level that enables particularly good absorption properties in the high-energy, i.e. short-wave, region of visible light as well. The compounds are thus of excellent suitability for use in photoactive organic electronic components, for example for components which convert sunlight to electrical power, for instance
 10 in photodetectors and light-sensitive transistors, particularly in organic solar cells.

The inventors have additionally found that the compound of the invention having an oxygen atom in the structural element:



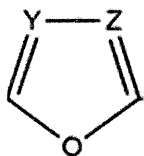
15 of formula (I) generally leads to better optical properties than is the case for compounds that are similar but lack oxygen. It has been found, for example, that the presence of O is preferable over S in this structural element. For example, furan is preferable over thiophene.

20 The inventors have also found that the effect possessed by said



structural element

of formula (I) that has just been described occurs especially in a compound having an A² group having at least two conjugated C=C double bonds. The common presence of the structural element



together with an electron-withdrawing group A^2 having at least two conjugated $C=C$ double bonds - according to the present invention - is a structure motif that has a surprisingly favorable effect on the absorption properties of the compound of the invention.

Moreover, the compounds of the invention generally exhibit good processibility and can be deposited by conventional methods in thin organic layers alone or together with further materials. They additionally have adequate thermal, chemical and electrochemical stability to satisfy the demands that are typically made on them in the manufacture and operation of photoactive organic electronic components.

Finally, the compounds are producible with a moderate degree of technical complexity and hence are also comparatively inexpensive.

15

There follows a specification of a series of preferred embodiments of the present invention:

in a preferred embodiment, exactly one of the three coefficients o , p and q is 1, while the two other coefficients are zero. This means that exactly one of the three conjugated D^1 to D^3 blocks is present in the compound.

The inventors of the present invention have recognized that even compounds having just one of the three conjugated D^1 to D^3 blocks together with the two five-membered rings surrounding them and the acceptor groups A^1 and A^2 exhibit excellent absorption in the short-wave region of the visible spectrum. Compared to compounds having more than one conjugated block, they are additionally more easily preparable since fewer synthesis steps are required. More particularly, they also have a lower molecular weight than analogous compounds having more than one conjugated block and usually have good evaporability for that reason. It has been shown, for example, that

many of these compounds can be evaporated under reduced pressure without leaving a residue. For this reason, these compounds generally have good depositability by means of gas phase deposition or other methods that entail prior evaporation or sublimation of the compound.

5 It is thus possible to use the compounds on the industrial scale as well for production of photoactive organic electrical components with a low level of complexity and expense.

In a different embodiment, more than one of the three coefficients o , p and q is non-zero. For example, exactly two of the three

10 coefficients may be 1 or all three coefficients are 1.

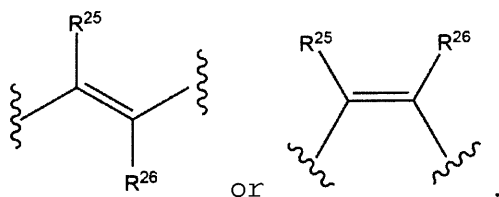
It is thus possible, for example, for exactly two of the three conjugated D^1 to D^3 blocks to be present, or exactly three of the conjugated D^1 to D^3 blocks. More conjugated blocks are also

15 conceivable (when $p > 1$).

The inventors of the present invention have recognized that the presence of more than one conjugated D^1 to D^3 block can facilitate processing in the liquid phase. This means that deposition of the compound in organic layers in the liquid phase can be conducted more

20 easily when more than just one conjugated D^1 to D^3 block is present.

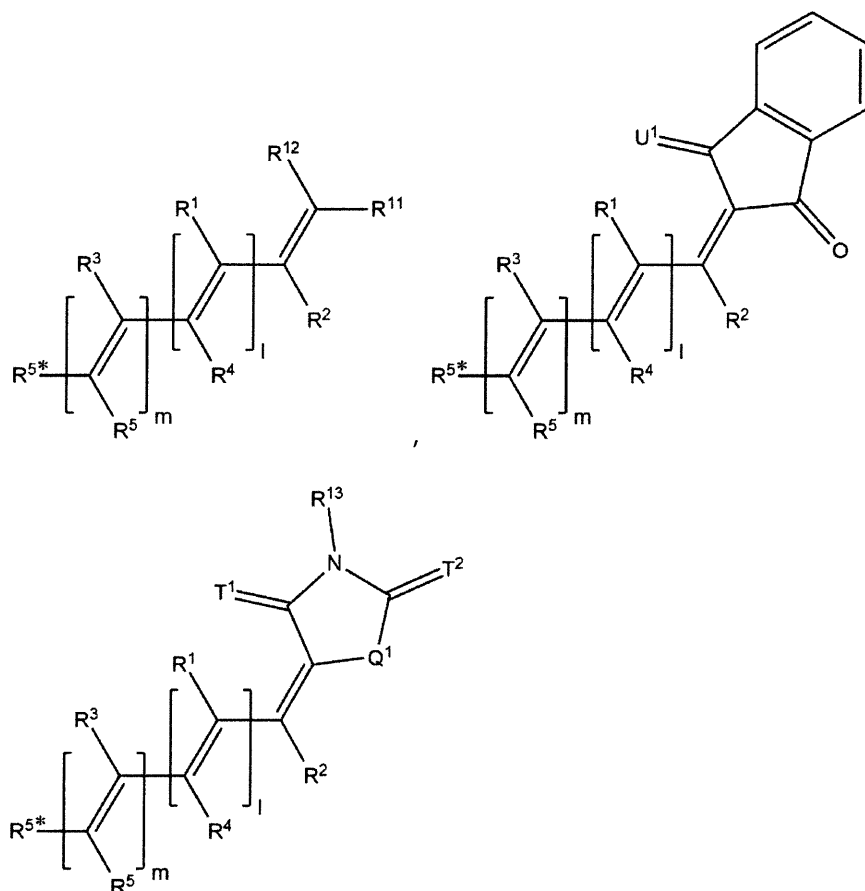
In a preferred embodiment of the invention, the compound has at least one conjugated D^1 to D^3 block which is not the structural unit:



This is favorable for the absorption properties.

25 One embodiment of the invention relates to the compound of the invention having a molecular weight between about 300 and about 2000 g/mol, especially a molecular weight not less than 330 g/mol and not more than 1200 g/mol.

A preferred embodiment of the invention relates to the compound of the invention where A^1 is selected from the group of the following radicals:

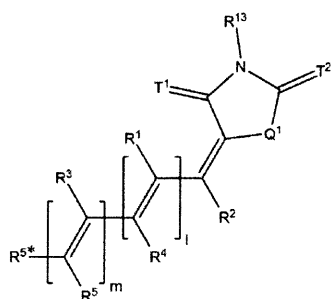


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where, in each of these three radicals for A^1 , either the E isomer or the Z isomer may each independently be present for each C=C double bond in each case.

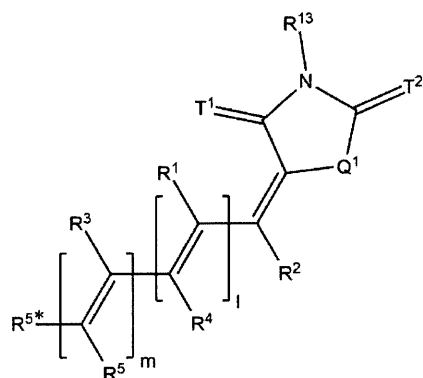
For each C=C double bond, either the E isomer ("E" = *entgegen* (opposite); i.e. trans configuration) or the Z isomer ("Z" = *zusammen* (together); i.e. cis configuration) may be present.

This is to be demonstrated hereinafter with reference to the example of the

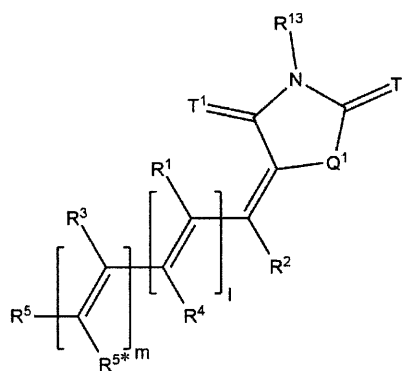


radical. Taking account of all E and Z isomers for the three C=C double bonds results in up to 8 stereoisomers for said radical:

Isomer 1:



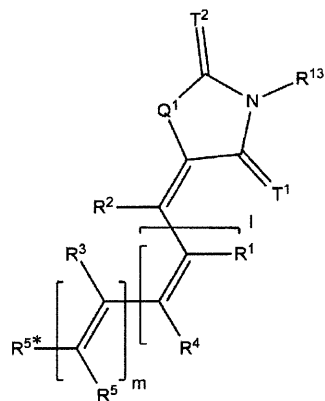
Isomer 2:



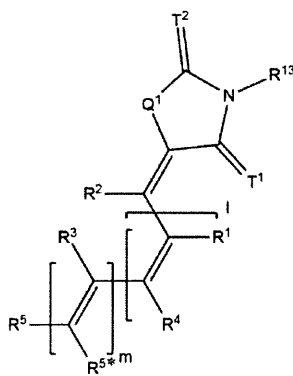
- 5 In isomer 1, the radicals on the first double bond, R^{5*} and R^3 , are arranged cis to one another, while R^{5*} and R^3 in isomer 2 are arranged trans to one another (isomer 2 can be obtained from isomer 1 by implementing a notional rotation by 180° about the first of the three C=C double bonds).

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Isomer 3:

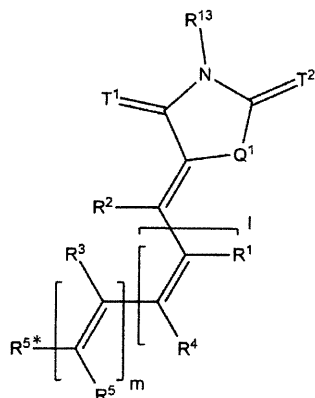


Isomer 4:

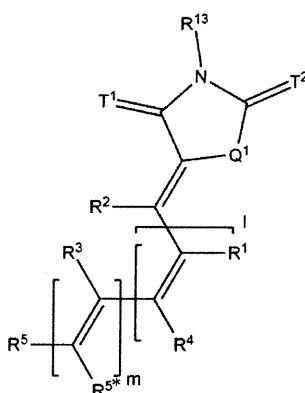


- 15 In isomer 1, R^1 and R^4 are arranged trans to one another, while they are arranged cis to one another in isomer 3 (isomer 3 can be obtained from isomer 1 by implementing a notional rotation by 180° about the second of the three C=C double bonds). In isomer 3, as in isomer 1, R^{5*} and R^3 on the first C=C double bond are in cis positions. In isomer 4, R^{5*} and R^3 , by contrast, are in trans positions (isomer 4 can be obtained from isomer 3 by implementing a notional rotation by 180° about the first of the three C=C double bonds).

Isomer 5:

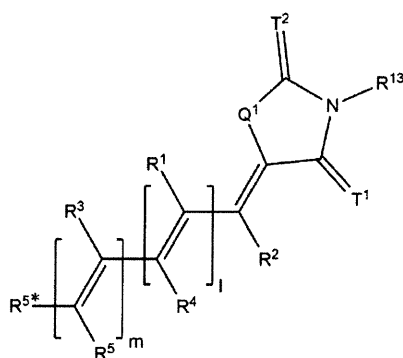


Isomer 6:

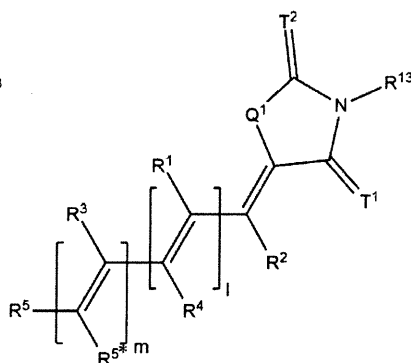


In isomer 3, Q^1 and R^2 are arranged cis to one another, while they are arranged trans to one another in isomer 5 (isomer 5 can be obtained from isomer 3 by implementing a notional rotation by 180° about the third of the three C=C double bonds). In isomer 5, as in isomer 1, R^{5*} and R^3 on the first C=C double bond are in cis positions. In isomer 6, R^{5*} and R^3 , by contrast, are in trans positions (isomer 6 can be obtained from isomer 5 by implementing a notional rotation by 180° about the first of the three C=C double bonds).

Isomer 7:



Isomer 8:



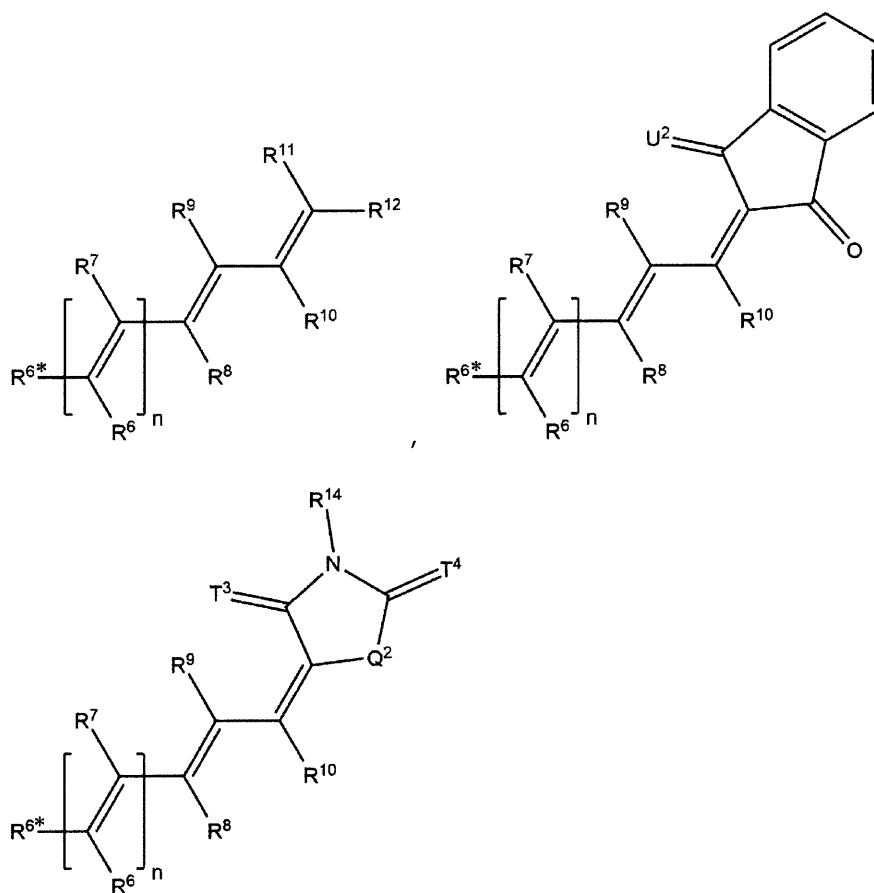
In isomer 1, Q^1 and R^2 are arranged cis to one another, while they are arranged trans to one another in isomer 7 (isomer 7 can be obtained from isomer 1 by implementing a notional rotation by 180° about the third of the three C=C double bonds). In isomer 7, as in isomer 1, R^{5*} and R^3 on the first C=C double bond are in cis positions. In the case of isomer 8, R^{5*} and R^3 , by contrast, are in trans positions (isomer 8 can be obtained from isomer 7 by implementing a notional rotation by 180° about the first of the three C=C double bonds).

In an analogous manner, for the other two specified radicals of A^1 and, there may in each case be up to 8 stereoisomers as result from

the E-Z isomerism in the up to three C=C double bonds. The stereoisomers are not shown explicitly merely for the sake of conciseness, but have a comparable effect with regard to their electronic properties. However, preference is given to the three radicals shown explicitly for A¹.

In this case, the coefficients m and l are each independently 0 or 1. For example, both coefficients may simultaneously be 0 or both may at the same time be 1. Preferably, exactly one of the two coefficients is 1 and the other of the two coefficients is 0.

10 A² is selected from the group of the following radicals:



where, in each of these three radicals for A², either the E isomer or the Z isomer may each independently be present for each C=C double bond in each case.

In an analogous manner to that already shown for A¹ above, for the three radicals of A¹ shown, there may be up to stereoisomers as result from the E-Z isomerism in the up to 3 C=C double bonds. The

stereoisomers are not shown explicitly merely for the sake of conciseness, but have a comparable effect with regard to their electronic properties. However, preference is given to the three radicals shown explicitly for A².

5 In this case, the coefficient n in each case is 0 or 1. Preferably, n is zero.

The R¹ to R¹⁰ and R^{5*} and R^{6*} radicals, for the A¹ and A² groups, are each independently selected from the group of the following radicals:

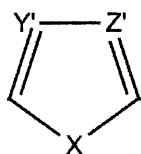
- H,
- 10 - halogen,
- CN,
- cyclic or open-chain C₁-C₂₀-alkyl,
- cyclic or open-chain C₂-C₂₀-alkenyl,
- cyclic or open-chain C₁-C₂₀-O-alkyl,
- 15 - aryl,
- heteroaryl,

where hydrogen atoms in the alkyl, alkenyl, O-alkyl, aryl and heteroaryl radicals may each independently be substituted and where it is possible in each case independently for a ring to be
 20 formed by the following pairs of radicals together: R¹ and R³, R² and R⁴, R⁴ and R⁵, R³ and R^{5*}, R⁷ and R⁹, R⁶ and R⁸, R⁸ and R¹⁰, R^{6*} and R⁷.

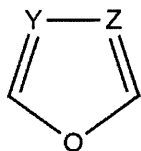
This applies in each case to the three radicals shown above and in the claim for A¹ and to the three radicals shown for A². It will be
 25 apparent to the person skilled in the art that a corresponding bridge or ring formation is equally possible in the E and Z isomers that have not been shown explicitly. Corresponding ring formation means here in each case that radicals arranged in cis positions to one another on a C=C double bond of A¹ can form a ring with one another.
 30 In addition, a radical attached to an atom group of A¹ which is attached to a C=C double bond of A¹ and is cis to a further radical on the same double bond can form a ring with this further radical. The same applies in each case to A². In other words: radicals (R¹ to R¹⁰) that are on the same side of the conjugated backbone of one of
 35 the A¹ or A² radicals and are in 1,2 positions to one another - on a

C=C double bond - or in 1,3 positions - on a C=C-C structural unit, i.e. are spatially adjacent, can form a ring with one another.

The statements made so far with regard to the A^1 and A^2 radicals are applicable with the proviso that, for A^1 , exactly one of the R^{5*} , R^5 , R^4 , R^3 , R^2 and R^1 radicals represents a linkage $\{$ by means of which A^1 is bonded to the structural element

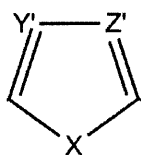


of the compound of the general formula (I), and with the further proviso that, for A^2 , exactly one of the R^{6*} , R^6 , R^7 , R^8 , R^9 and R^{10} radicals represents a linkage $\{$ by means of which A^2 is bonded to the structural element



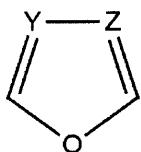
of the compound of the general formula (I).

Preferably, exactly one of the R^{5*} , R^5 and R^4 radicals is the linkage $\{$ by which A^1 is bonded to the structural element



of the compound of the general formula (I). More particularly, the R^{5*} radical is the linkage $\{$.

Preferably, exactly one of the R^{6*} , R^6 and R^8 radicals is the linkage $\{$ by which A^2 is bonded to the structural element



of the compound of the general formula (I). More particularly, the R^{6*} radical is the linkage --- .

As specified, for R^1 to R^{10} and R^{5*} and R^{6*} , hydrogen atoms in the alkyl, alkenyl, O-alkyl, aryl and heteroaryl radicals may each
 5 independently be substituted. For example, hydrogen atoms may be replaced by halogen atoms, for example fluorine atoms.

In the case of formation of a ring by pairs of radicals, the ring may be a substituted or unsubstituted five-, six- or seven-membered ring. For example, it may be a cyclopentene, cyclohexene or cycloheptene
 10 ring.

The terms halogen, CN, cyclic or open-chain C_1 - C_{20} -alkyl, cyclic or open-chain C_2 - C_{20} -alkenyl, cyclic or open-chain C_1 - C_{20} -O-alkyl, aryl and heteroaryl should each likewise be understood as already elucidated in connection with the R^a to R^c radicals.

15 The R^{11} and R^{12} radicals for the A^1 and A^2 groups are each independently selected from the group of the radicals:

- H,
- CN,
- COOR^f where R^f is selected from the group of radicals: H and
 20 cyclic or open-chain C_1 - C_{20} -alkyl, where hydrogen atoms in the alkyl may be replaced by fluorine atoms,
 with the proviso that R^{11} and R^{12} cannot both at the same time be H.

For example, exactly one of the R^{11} or R^{12} radicals may be CN and the other of the two radicals may be H. More particularly, it is also
 25 possible that R^{11} and R^{12} are both CN. It is likewise possible, for example, for one of the R^{11} or R^{12} radicals to be COOR^f and for the other of the two radicals to be H or CN. It is also possible for both radicals at the same time to be COOR^f .

The R^{13} and R^{14} radicals, for the A^1 and A^2 groups, are each
 30 independently selected from the same group of radicals as R^d and R^e .

U^1 , U^2 and T^1 to T^4 , for the A^1 and A^2 groups, are each independently selected from the group consisting of:

- O,

- S and
- $C(CN)_2$.

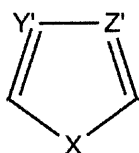
For example, U^1 and U^2 may each be the same. For example, U^1 and U^2 may each be O or each be S. For example, is also possible for each of T^1 to T^4 to be the same. For example, T^1 to T^4 may each be O. For example, T^1 to T^4 may also each be S.

Q^1 and Q^2 for the A^1 and A^2 groups are each independently selected from the group consisting of O and S.

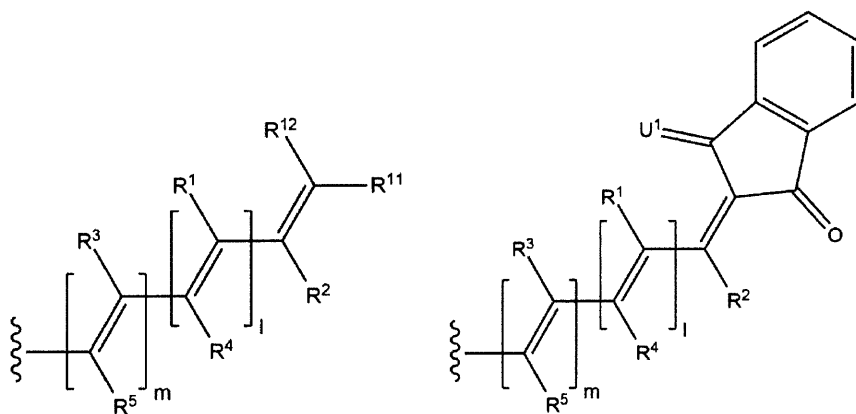
For example, Q^1 and Q^2 may be the same. For example, Q^1 and Q^2 may each be O or each be S.

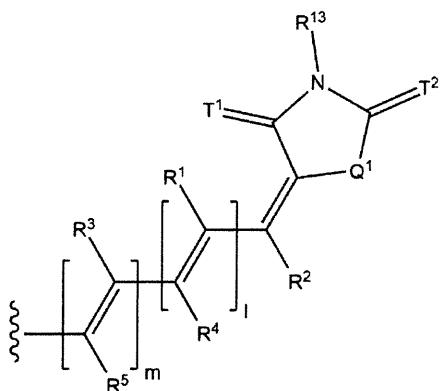
When A^1 and A^2 are chosen as described in this embodiment, this has a particularly favorable effect on the absorption properties.

A particularly preferred embodiment relates to the compound of the invention where, for A^1 , the R^{5*} radical represents the linkage --- by means of which A^1 is bonded to the structural element



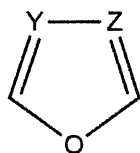
of the compound of the general formula (I), such that A^1 is selected from the group of the following radicals:



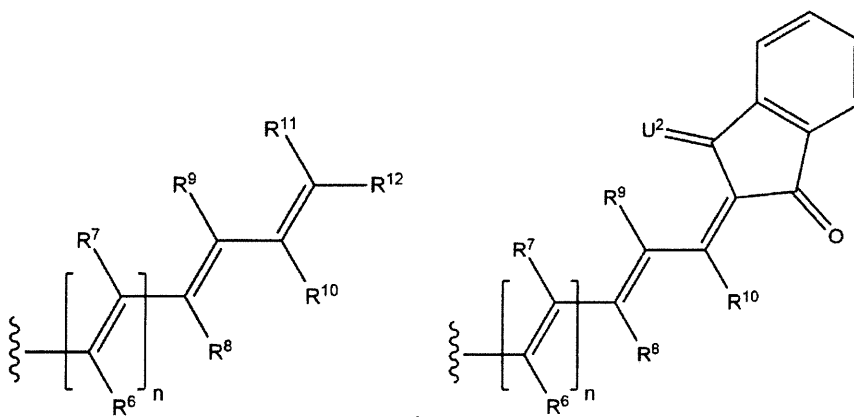


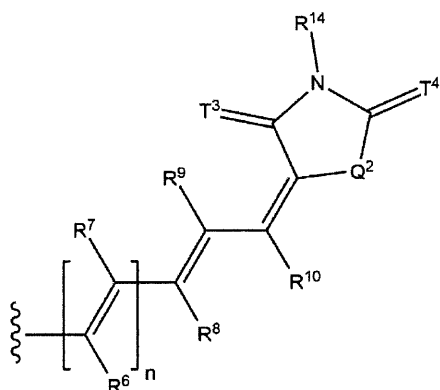
where, in each of these three radicals for A^1 , for each C=C double bond independently, either the E isomer or the Z isomer may be present.

- 5 In addition, in this embodiment, for A^2 , the R^{6*} radical represents the linkage --- by means of which A^2 is bonded to the structural element



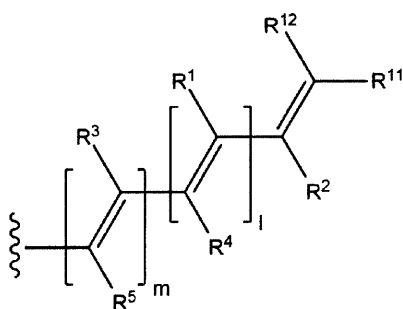
of the compound of the general formula (I), such that A^2 is selected from the group of the following radicals:





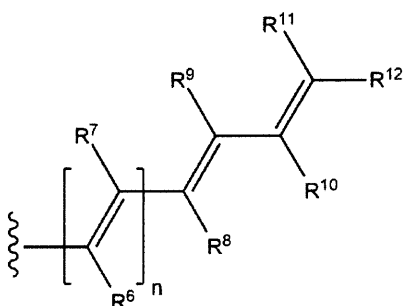
where, in each of these three radicals for A^2 , for each C=C double bond independently, either the E isomer or the Z isomer may be present.

- 5 In a preferred embodiment of the invention, the compound of the formula (I) is symmetric, for example mirror-symmetric. More particularly, the molecule may have a mirror plane at right angles to the longitudinal axis of the molecule. In that case, the synthesis of the compound of the invention can be simplified.
- 10 In one embodiment of the compound according to the invention, the two electron-withdrawing groups A^1 and A^2 are each identical. It has been found that a certain degree of symmetry or virtually symmetric structures often show particularly favorable absorption properties. In many cases, this also facilitates the synthesis of the compound.
- 15 A development of the invention has, as A^1 ,



20

and, as A^2 ,



Compounds having these side chains are readily obtainable by means of Knoevenagel condensation. The preparation thereof is technically
 5 simple to implement. Moreover, these groups are good acceptors, especially when at least one of the two R^{11} or R^{12} radicals is CN.

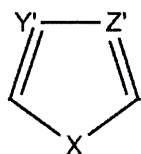
A preferred development of the invention relates to the compound of the invention where each of the R^{11} and R^{12} radicals is CN.

By virtue of the total of four nitrile groups in this case, it is
 10 possible to achieve a particularly good acceptor effect of the two A^1 and A^2 groups. The acceptor effect is of significance for the position of the energy levels which essentially determine the absorption properties. With compounds of the form described, it was possible to observe particularly good absorption in the high-energy
 15 region of visible light as well, in interplay with the other molecular units of the compound of the invention.

A preferred form of the invention is the compound of the invention where the R^1 to R^{10} and R^{5*} and R^{6*} radicals are each independently selected from the group of the following radicals:

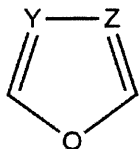
- 20 - H,
 - F,
 - C_1 - C_5 -alkyl, where hydrogens in the alkyl may each independently be replaced by fluorine atoms.

Here too, in accordance with the general structure of the compound of
 25 the invention, the proviso is applicable that, for A^1 , exactly one of the R^{5*} , R^5 , R^4 , R^3 , R^2 and R^1 radicals represents a linkage --- by means of which A^1 is bonded to the structural element



of the compound of the general formula (I). In addition,
 30 correspondingly, the proviso is applicable that, for A^2 , exactly one

of the R^{6*} , R^6 , R^7 , R^8 , R^9 and R^{10} radicals represents a linkage $\{$ by means of which A^2 is bonded to the structural element



of the compound of the general formula (I).

5 Preferably, the attachment of A^1 is again by means of R^{5*} , R^5 and R^4 , especially R^{5*} . Likewise preferably, the attachment of A^2 is by means of R^{6*} , R^6 and R^8 , especially R^{6*} .

In this embodiment too, in accordance with the general structure of the compound of the invention, the following pairs of radicals: R^1 and R^3 , R^2 and R^4 , R^4 and R^5 , R^3 and R^{5*} , R^7 and R^9 , R^6 and R^8 , R^8 and R^{10} , R^{6*} and R^7 may form a ring with one another. The ring may especially be a five-, six- or seven-membered ring. For example, it may be a cyclopentene, cyclohexene or cycloheptene.

The C_1 - C_5 -alkyl may in each case also be linear or branched. The alkyl radical may also be partly or fully fluorinated, preferably perfluorinated, but may also be free of fluorine atoms.

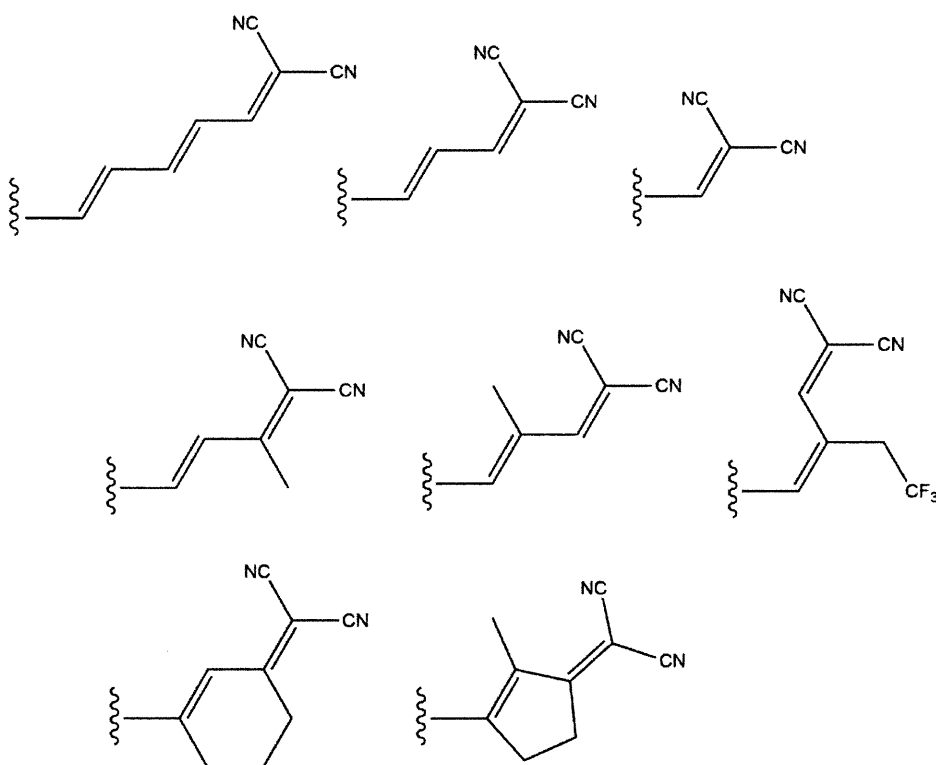
The compound of the invention does not require any long-chain R^1 to R^{10} and R^{5*} and R^{6*} radicals. Instead, the inventors have observed that the desired high absorption can also be achieved with the radicals described here. This can be advantageous when the compound is to be evaporable for the purpose of processing without thermal breakdown. Moreover, compounds having the radicals mentioned, which are of comparatively small size, are preparable with higher atom efficiency and usually also more easily synthesizable than compounds with larger R^1 to R^{10} and R^{5*} and R^{6*} radicals.

In one embodiment of the present invention, the compound of the invention has R^1 to R^{10} and R^{5*} and R^{6*} radicals, at least one of which is a fluorine atom or a fluorinated alkyl. Preferably, at least two or even more of the R^1 to R^{10} radicals are fluorine atoms or fluorinated alkyl radicals. The introduction of electron-withdrawing

fluorine can affect the position of the energy levels of the molecular orbitals.

In another development, at least four of the R^1 to R^{10} and R^{5*} and R^{6*} radicals are hydrogen atoms, preferably at least six. In this case, the electron-withdrawing A^1 and A^2 groups are generally preparable in a particularly simple manner.

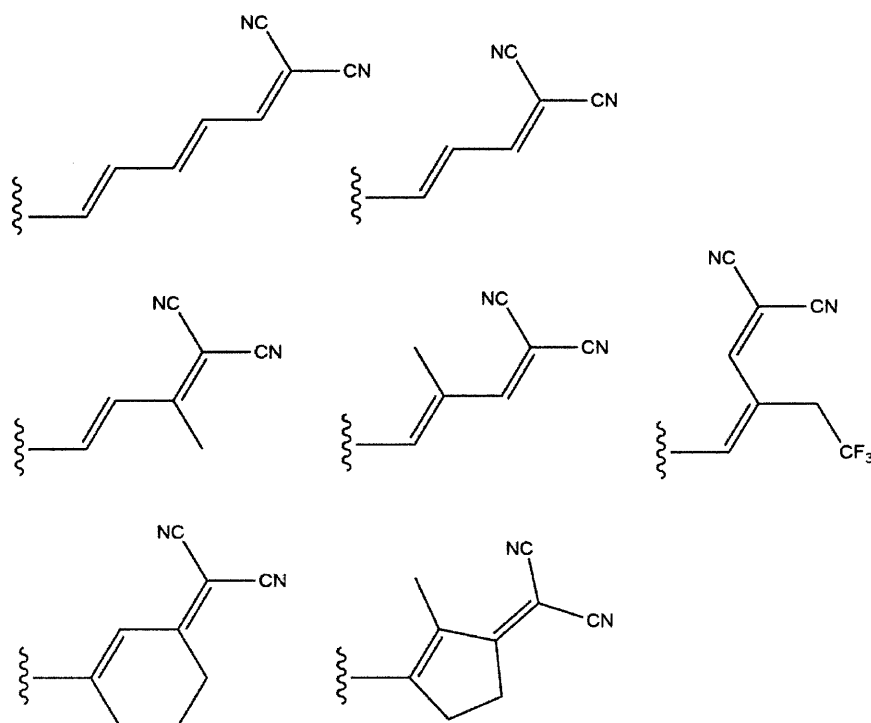
A particularly preferred embodiment of the compound of the invention has an A^1 selected from the group of the following radicals:



10

These groups for A^1 are excellent acceptors, have a good electron-withdrawing effect, are preparable without any great complexity and have been found to be useful for the preparation of compounds having particularly good absorption properties.

15 A likewise particularly preferred embodiment of the compound of the invention has an A^2 selected from the group of the following radicals:



These groups for A² are excellent acceptors, have a good electron-withdrawing effect, are preparable without any great complexity and have been found to be useful for the preparation of compounds having particularly good absorption properties.

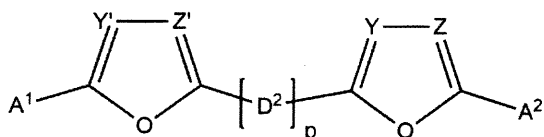
A particularly preferred embodiment of the invention relates to the compound of the invention where X is oxygen (O). In this case, each of the five-membered rings which surround the middle conjugated D¹ to D³ blocks has an oxygen atom in the ring. For example, the two five-membered rings may be furans.

By virtue of the fact that oxygen is chosen for X, there is an increase in the symmetry of the compound. The symmetry of compounds often plays an important role in electron transitions. The inventors of the present invention have recognized that the compounds with X = O exhibit particularly good absorption properties. The structural element comprising X may, for example, be a furan.

For example, it has been found that the use of two furans for the outer five-membered rings leads to higher absorption than is the case with thiophenes.

A preferred embodiment of the present invention relates to the compound of the invention with X = oxygen, with m = n = 0, with o = q

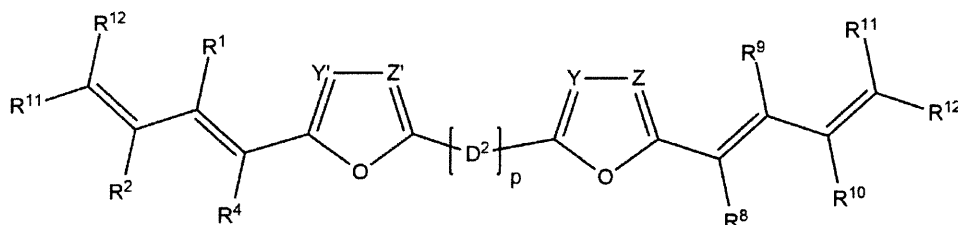
= 0 and with p selected from: 1, 2, 3, 4 and 5, having the general formula:



5

Compounds of this kind are obtainable with a low level of technical complexity and have particularly good absorption properties. They are of good suitability for use, for example, in photoactive organic components.

- 10 A particularly preferred embodiment of the present invention relates to the compound of the invention where X is oxygen and where the coefficients m, n, o and q are each zero. In addition, p is selected from 1, 2, 3, 4 and 5. A compound of this kind has the following general formula:



15

- A compound of this formula has two acceptors A¹ and A² that are similar or identical in terms of their basic structure, and two five-membered rings, each of which has an oxygen atom in the ring structure. Preferably, the two five-membered rings are furans, where
- 20 the furans may also be substituted. Compounds of the formula described do not just have good synthetic obtainability and good suitability for the production of layers for photoactive organic electronic components, but also exhibit particularly good absorption properties, particularly for the wavelength range between 400 and
- 25 600 nm. Specifically for wavelengths below 500 nm, much higher absorptions are generally possible than with most conventional compounds. For example, with these compounds, stronger absorption is achievable than with comparable compounds in which the D²-surrounding five-membered rings are thiophenes. The improved absorption can be
- 30 utilized for the attainment of higher sensitivities of photodetectors

or of light-sensitive field-effect transistors and especially for the achievement of a higher efficiency of organic solar cells. All these applications require organic compounds which, like the compound of the invention, can absorb and thus make it possible to utilize
 5 sunlight of different wavelength.

In a preferred embodiment of the two embodiments of the compound of the invention just mentioned, $p = 1$. This is favorable, for example, if the compound is to be evaporable. When $p = 1$, there are also fewer reaction steps required.

10 One development of the invention relates to the compound of the invention where Y, Y', Z and Z' are each independently selected from: N or CR^a where R^a is selected from the group of the following radicals:

- H
- 15 - F,
- C₁-C₅-alkyl,
- C₁-C₅-O-alkyl,
- C₁-C₅-S-alkyl,
- C₂-C₅-alkenyl,
- 20 - C₂-C₅-O-alkenyl,
- C₂-C₅-S-alkenyl,
- C₂-C₅-alkynyl,
- phenyl,

where hydrogen atoms in the alkyl, O-alkyl, S-alkyl, alkenyl, O-alkenyl, S-alkenyl, alkynyl and phenyl radicals may each
 25 independently be substituted, especially replaced by fluorine atoms.

The alkyl, O-alkyl, S-alkyl, alkenyl, O-alkenyl, S-alkenyl, alkynyl radicals may each also be linear or branched.

30 R^a for each of the different placeholders Y, Y', Z and Z' may be chosen differently.

Further preferably, Y, Y', Z, Z' are each independently selected from: N, CH, C-F, C-CH₃, C-CF₃, C-C₂H₅, C-C₃H₈, C-OCH₃, C-OC₂H₅, C-SCH₃, C-SC₂H₅. Compounds having these radicals that are not very sterically

demanding on the two five-membered rings often allow a technically less complex synthesis.

In one embodiment, at least one of the positions Y, Y', Z and Z' is N. The inventors have found that the presence of N at one of the Y, Y', Z and Z' positions leads controlled lowering of the highest molecular orbital occupied by electrons (HOMO). This allows the absorption spectrum of the compound of the invention to be shifted toward shorter wavelengths. When two or more of the Y, Y', Z and Z' positions are occupied by N, the effect is enhanced. Accordingly, it may also be preferable that exactly 2, 3 or even 4 of the Y, Y', Z and Z' positions are occupied by N.

Most preferably, Y, Y', Z, Z' are each CH. In this case, the two five-membered rings that surround the conjugated D¹ to D³ blocks are each furan rings. This increases the symmetry of the molecule, which is a possible reason for the particularly favorable absorption properties of these compounds, without being bound by theory.

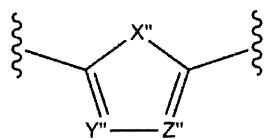
Another embodiment of the invention relates to the compound of the invention where the compound has at least one conjugated D¹ to D³ block having at least one substituent, where the substituent is a fluorine atom or a fluoroalkyl. The inventors of the present invention have found that the fluorine substituents generally lead to a certain lowering of energy of the HOMO of the compound of the invention for each substituent. The extent of the effect depends on the size of the orbital coefficient of the HOMO on the respective carbon atom to which the fluorine substituent binds in the compound of the invention. This generally leads to a shift in the absorption spectrum toward shorter wavelengths. Finally, the inventors have also found that fluorine substituents can form S-F interactions with sulfur atoms of adjacent S-containing rings, which can promote higher co-planarity of the compound of the invention. This frequently improves the charge transport properties of the compound. This can also have a favorable effect on the absorption.

Another embodiment of the invention relates to the compound of the invention where the compound has at least one conjugated D¹ to D³ block having at least one C₁-C₂₀-alkyl alkyl substituent, preferably

C₁-C₁₀-alkyl, especially C₁-C₅-alkyl. The inventors of the present invention have found that alkyl substituents have an electron-donating effect to a minor degree. They can lead to a slight rise in the HOMO of the compound of the invention, the extent of the effect depending on the size of the orbital coefficient of the HOMO on the particular carbon atom to which the alkyl substituent binds in the compound of the invention.

Another embodiment of the invention relates to the compound of the invention where the compound has at least one conjugated D¹ to D³ block having at least one O-alkyl substituent C₁-C₂₀-O-alkyl, preferably C₁-C₁₀-O-alkyl, especially C₁-C₅-O-alkyl. O-Alkyl substituents, i.e. alkoxy groups, feature a much more marked electron-donating effect much stronger than that of alkyl substituents. O-Alkyls thus lead to a rise in the HOMO. The introduction of O-alkyl substituents can enable a shift in the absorption spectrum toward longer wavelengths. Moreover, O-alkyl groups are less sterically demanding than alkyl groups and can contribute, via S-O or O-H interactions, to stiffening of the molecular structure of the compound of the invention.

Another embodiment of the invention relates to a compound of the invention where at least one of the conjugated D¹ to D³ blocks that must be present in the compound has the general formula

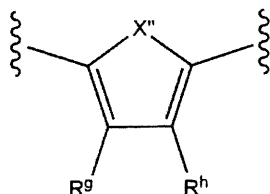


In this case, the compound has a total of at least three aromatic five-membered rings as part of a conjugated π -electron system. This combination has been found to be particularly favorable for the absorption properties in experiments.

In one embodiment, at least one of the Y'' and Z'' positions is N. The inventors have found that the presence of N at one of the Y'' and Z'' positions leads controlled lowering of the highest molecular orbital occupied by electrons (HOMO). The effects are comparable here

with the effects described above for N at one of the Y, Y', Z and Z' positions.

It is particularly preferable in another embodiment when at least one of the conjugated D¹ to D³ blocks that must be present in the compound 5 has the general formula



where the R^g and R^h radicals are independently selected from the group of the following radicals:

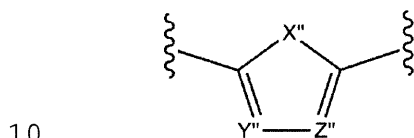
- H
- 10 - F,
- C₁-C₅-alkyl, where individual carbon atoms may be replaced by heteroatoms,
- C₁-C₅-O-alkyl,
- C₁-C₅-S-alkyl,
- 15 where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be substituted by fluorine,
- where the R^g and R^h radicals may be joined to one another in the form of a ring structure, and
- where an aryl radical may be fused to the ring structure. The
- 20 latter aryl radical may also be substituted, for example fluorinated.

The alkyl, O-alkyl and S-alkyl radicals may each also be linear or branched.

The ring structure may, for example, be a five-, six- or seven-
 25 membered ring which, as well as carbon atoms, may also have oxygen or sulfur atoms. The ring may thus be heterocyclic or homocyclic. The ring is preferably saturated. For example, the ring may be substituted. For example, the ring may have fluorine atoms or alkyl groups as substituents. The ring may also have at least partly
 30 fluorinated alkyl groups as substituents. The fluorination can achieve an electron-withdrawing effect.

In a preferred embodiment of the embodiment just mentioned, R^g and R^h are each independently selected from the group of the radicals, H, F, methyl, methoxy, ethyl, ethyloxy, propyl, propyloxy, where hydrogen atoms in each of methyl, methoxy, ethyl, ethyloxy, propyl and
 5 propyloxy may be substituted by fluorine.

Particular preference is given to compounds of the invention where $X'' = S$. Preference is thus given to compounds of the invention having, for at least one of the three conjugated D^1 to D^3 blocks, a five-membered ring of the general formula

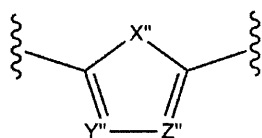


where X'' is sulfur.

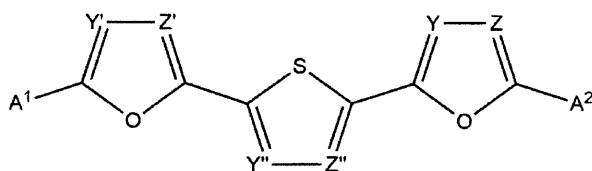
It is most preferable when the ring is a substituted or unsubstituted thiophene ring, i.e. when no further heteroatoms are present in the five-membered ring aside from sulfur.

15 The use of a five-membered ring including sulfur as one of the conjugated blocks for D^1 to D^3 for achievement of high absorption values at short wavelengths of visible light has been found to be particularly favorable experimentally.

A further particular embodiment of the invention relates to the
 20 compound of the invention where X is oxygen and where there is exactly one conjugated block of D^1 to D^3 , i.e. exactly one of the coefficients o, p and q is 1, while the two others are each zero, in which the conjugated block is

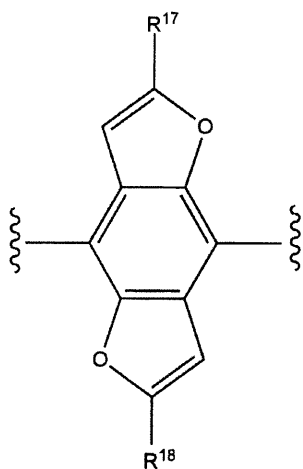


25 where X'' is sulfur. In this case, the compound is a compound of the following general formula:



A combination of two outer five-membered rings each with an oxygen and a middle five-membered ring with sulfur in conjunction with the two acceptors A¹ and A² has been found to be a particularly suitable structural element in order to achieve the favorable absorption properties in the form of a readily obtainable and hence inexpensive compound.

A further embodiment relates to the compound of the invention where there is at least one of the conjugated D¹ to D³ blocks in the compound and it has the general formula



where R¹⁷ and R¹⁸ are independently selected from the group of the following radicals:

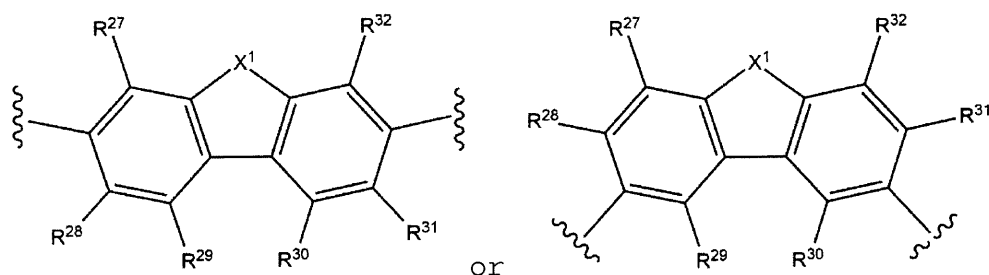
- H,
- F,
- C₁-C₅-alkyl,
- C₁-C₅-O-alkyl,
- C₁-C₅-S-alkyl,

where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms. The alkyl, O-alkyl and S-alkyl radicals here may each also be linear or branched.

The inventors of the present invention have observed that this structural element is of excellent suitability as one of the conjugated D¹ to D³ blocks in order to obtain compounds having the desired high absorption properties.

- 5 Further preferably, R¹⁷ and R¹⁸ are each hydrogen, methyl, ethyl, methoxy, ethoxy. Most preferably, R¹⁷ and R¹⁸ are each hydrogen.

A development relates to the compound of the invention where there is at least one of the conjugated D¹ to D³ blocks in the compound and it
10 has the general formula



where X¹ is selected from: NR¹, CR¹R^m,

where R¹ and R^m are each independently selected from the group of the radicals:

- 15 - H,
 - open-chain C₁-C₅-alkyl,
 - C₅-C₁₂-aryl
 - C₅-C₁₂-heteroaryl

where hydrogen atoms in the open-chain C₁-C₅-alkyl may at least
20 partly be replaced by fluorine atoms, and where hydrogen atoms in the C₅-C₁₂-aryl and the C₅-C₁₂-heteroaryl may be substituted, for example by fluorine atoms, and

where the open-chain C₁-C₅-alkyl may be linear or branched, and where R²⁷ to R³² are independently selected from the group of the
25 following radicals:

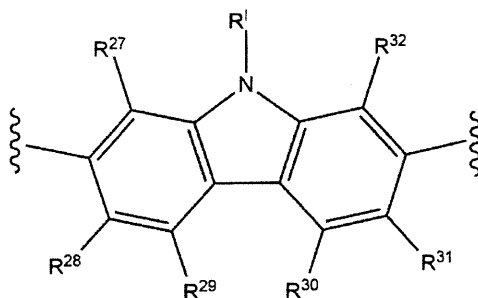
- H,
 - F,
 - C₁-C₅-alkyl,
 - C₁-C₅-O-alkyl,

- C₁-C₅-S-alkyl,

where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms and where the radicals may each independently be linear or branched.

5 For example, the C₅-C₁₂-aryl is the R¹ radical and R^m is a phenyl which may in turn be substituted.

A further embodiment relates to the compound of the invention where there is at least one of the conjugated D¹ to D³ blocks in the compound and it has the general formula



10 where R¹ is H or an open-chain C₁-C₅-alkyl or phenyl, and where R²⁷ to R³² are independently selected from the group of the following radicals:

- H,
- 15 - F,
- C₁-C₅-alkyl,
- C₁-C₅-O-alkyl,
- C₁-C₅-S-alkyl,

20 where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms. The alkyl, O-alkyl and S-alkyl radicals may each also independently be linear or branched.

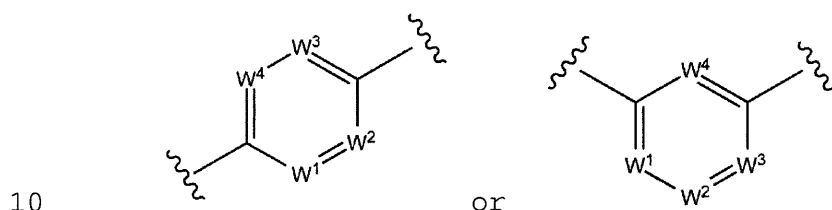
The inventors of the present invention have observed that this structural element is of excellent suitability as one of the
 25 conjugated D¹ to D³ blocks in order to obtain compounds having the desired high absorption properties. Just like fluorene, carbazole tends to lead to a short-wave shift in absorption and to a lowered HOMO compared to the use of a thiophene or furan as conjugated block. Carbazole is a stronger donor than fluorene, and so the HOMO of

carbazole derivatives is usually higher than that of analogous fluorenes.

Preferably, R^1 is H, methyl, ethyl, propyl or butyl.

It is further preferable when R^{27} to R^{32} are each selected from the group comprising: H, F, methyl, ethyl, methoxy, ethoxy. For example, it is also possible for all R^{27} to R^{32} radicals to each be hydrogen.

A preferred development relates to the compound of the invention where there is at least one of the conjugated D^1 to D^3 blocks in the compound and it has the general formula



where W^1 to W^4 are independently selected from: N and CR^n ,
where R^n is selected from the group of the following radicals:

- H,
- F,
- 15 - C_1 - C_5 -alkyl,
- C_1 - C_5 -O-alkyl,
- C_1 - C_5 -S-alkyl,

where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms. The alkyl, O-alkyl and S-alkyl radicals may each also independently be linear or branched.

20

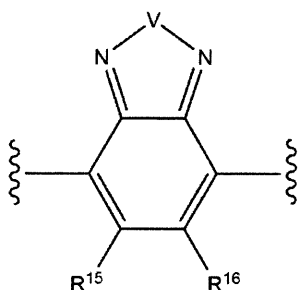
The inventors of the present invention have observed that this structural element is of excellent suitability as one of the conjugated D^1 to D^3 blocks in order to obtain compounds having the desired high absorption properties. Incorporation generally leads to a short-wave shift in absorption and lowered HOMO compared to the use of a thiophene or furan as conjugated block.

25

It is further preferable when R^n , for W^1 to W^4 , is in each case independently selected from H, methyl, methoxy, ethyl, ethoxy, propyl, propyloxy.

30

A further development relates to the compound of the invention where there is at least one of the conjugated D¹ to D³ blocks in the compound and it has the general formula



5 R¹⁵ and R¹⁶ here are preferably selected from the group of the following radicals:

- H,
- F,
- C₁-C₅-alkyl,
- 10 - C₁-C₅-O-alkyl,
- C₁-C₅-S-alkyl,

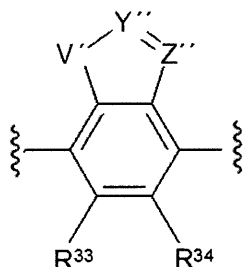
where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms. The alkyl, O-alkyl and S-alkyl radicals may each also independently be linear
15 or branched.

For example, R¹⁵ and R¹⁶ may be H, F, methyl, ethyl, methoxy and ethoxy.

The inventors of the present invention have recognized that this structural element is likewise suitable as one of the conjugated D¹
20 to D³ blocks in order to obtain compounds having good absorption properties. Incorporation of this structural element generally leads to improved co-planarity with respect to the neighboring structural units. A shift in the absorption spectrum toward longer wavelengths can thus be brought about in a controlled manner.

25 In a preferred embodiment of the embodiment just mentioned, V is sulfur or NR^k where R^k is selected from the group of H and C₁-C₅-alkyl.

A preferred development of the invention relates to the compound of the invention where there is at least one of the conjugated D¹ to D³ blocks in the compound and it has the general formula



5 where R³³ to R³⁴ are each independently selected from the group of the following radicals:

- H,
- F,
- C₁-C₅-alkyl,
- 10 - C₁-C₅-O-alkyl,
- C₁-C₅-S-alkyl,

where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms, and

where V' is selected from: O, S, Se or NR^k;

15 where Y'' is selected from: N or CR^g;

where Z'' is selected from: N or CR^h;

where R^k is selected from the group of the radicals:

- H,
- open-chain C₁-C₅-alkyl,
- 20 - C₅-C₁₂-aryl
- C₅-C₁₂-heteroaryl

where hydrogen atoms in the open-chain C₁-C₅-alkyl may at least partly be replaced by fluorine atoms and where hydrogen atoms in the C₅-C₁₂-aryl and the C₅-C₁₂-heteroaryl may at least partly be

25 substituted,

where R^g and R^h are selected independently like R^a.

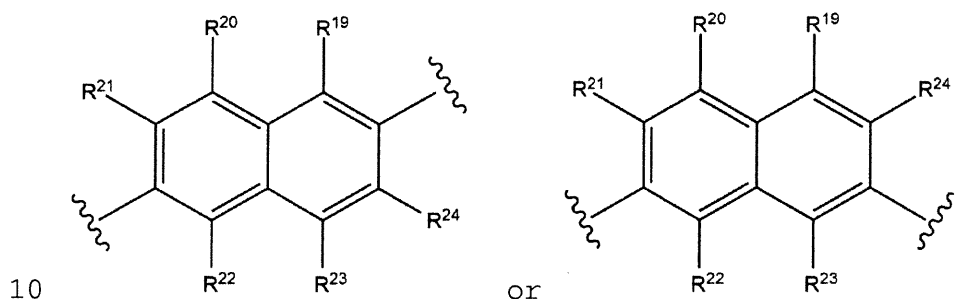
The inventors of the present invention were able to observe that compounds of this kind have particularly high absorption and are of surprisingly good suitability for use in photoactive organic

30 components.

In a preferred embodiment of the development just mentioned, the R^{33} to R^{34} radicals are each independently selected from the group of: H, F, methyl, ethyl, methoxy and ethoxy, where methyl, ethyl, methoxy and ethoxy may each be at least partly fluorinated. For example, R^{33} to R^{34} are each hydrogen.

In a preferred embodiment, R^k is hydrogen.

A preferred development relates to the compound of the invention where there is at least one of the conjugated D^1 to D^3 blocks in the compound and it has the general formula



R^{19} to R^{24} here are preferably selected from the group of the following radicals:

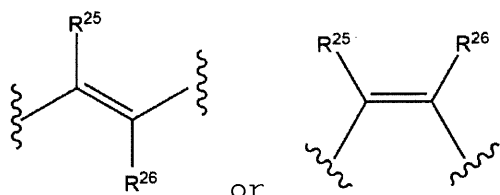
- H,
- F,
- 15 - C_1 - C_5 -alkyl,
- C_1 - C_5 -O-alkyl,
- C_1 - C_5 -S-alkyl,

where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms. The alkyl, O-alkyl and S-alkyl radicals may in each case also independently be linear or branched.

For example, R^{19} to R^{24} may be H, F, methyl, ethyl, methoxy, ethoxy, propyl and propyloxy.

The inventors of the present invention have recognized that this structural element is likewise suitable as one of the conjugated D^1 to D^3 blocks in order to obtain compounds having good absorption properties. Naphthalene generally leads to absorption at shorter wavelengths and to a lowered HOMO compared to the use of a thiophene or furan as conjugated block.

A further embodiment of the invention relates to the compound of the invention where there is at least one of the conjugated D¹ to D³ blocks in the compound and has the general formula



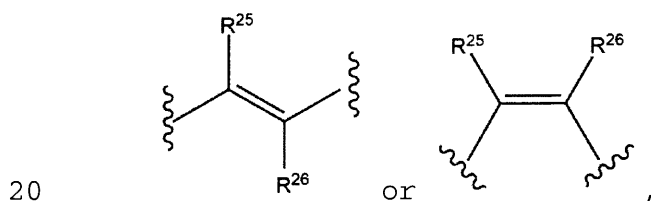
5 R²⁵ and R²⁶ may each independently preferably be selected from the group of the following radicals:

- H,
- F,
- C₁-C₅-alkyl,
- 10 - C₁-C₅-O-alkyl,
- C₁-C₅-S-alkyl,

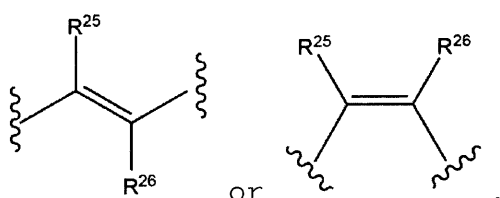
where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms. The alkyl, O-alkyl and S-alkyl radicals may each also independently be linear
15 or branched.

For example, R²⁵ and R²⁶ may be H, F, methyl, ethyl, methoxy and ethoxy. Particular preference is given to H, F and methyl.

In another embodiment, at least one of the conjugated D¹ to D³ blocks is only a structural unit of the general formula

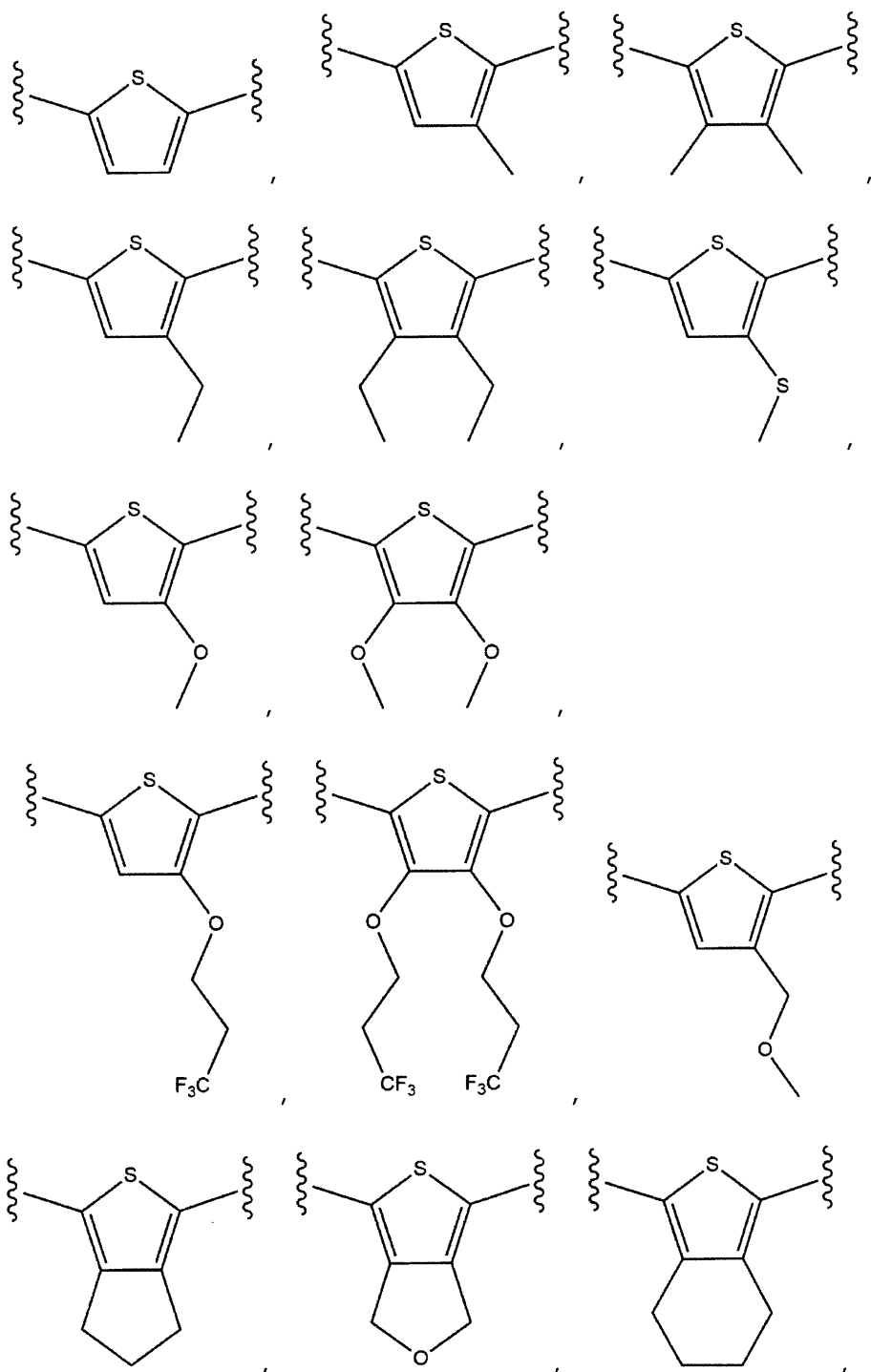


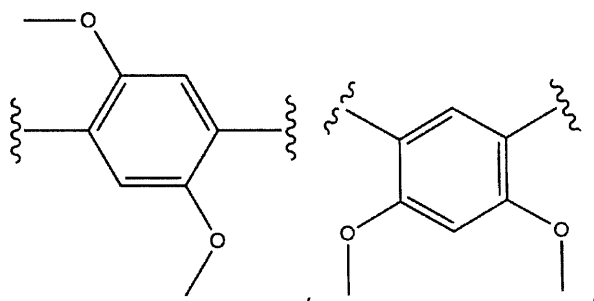
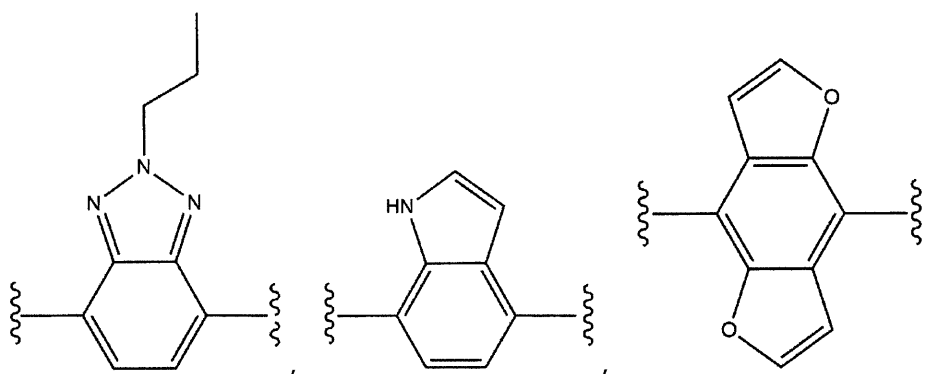
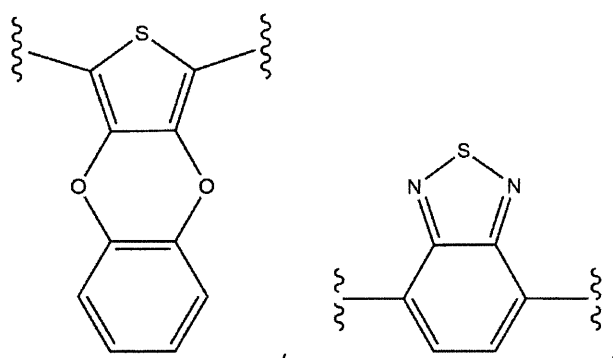
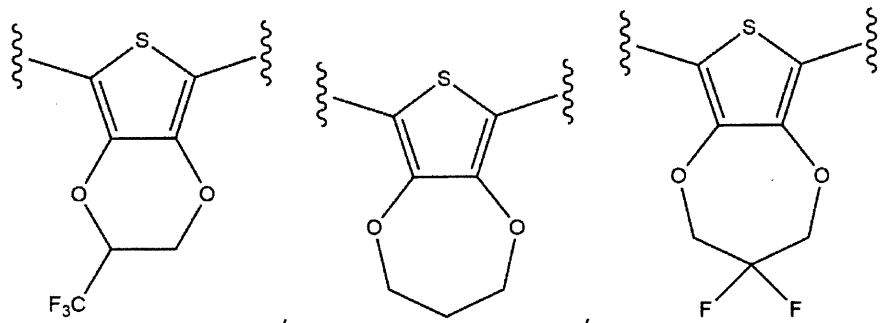
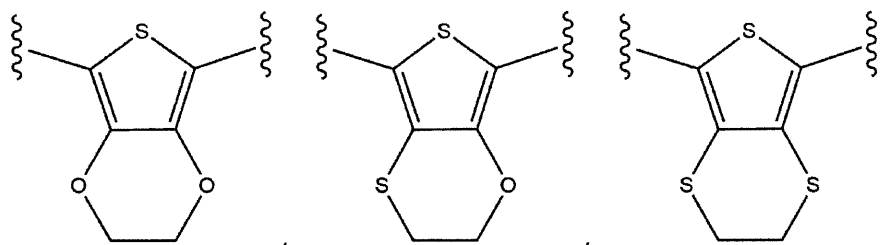
if there is at least one further donor D¹ to D³ which is not a conjugated block of the structural unit

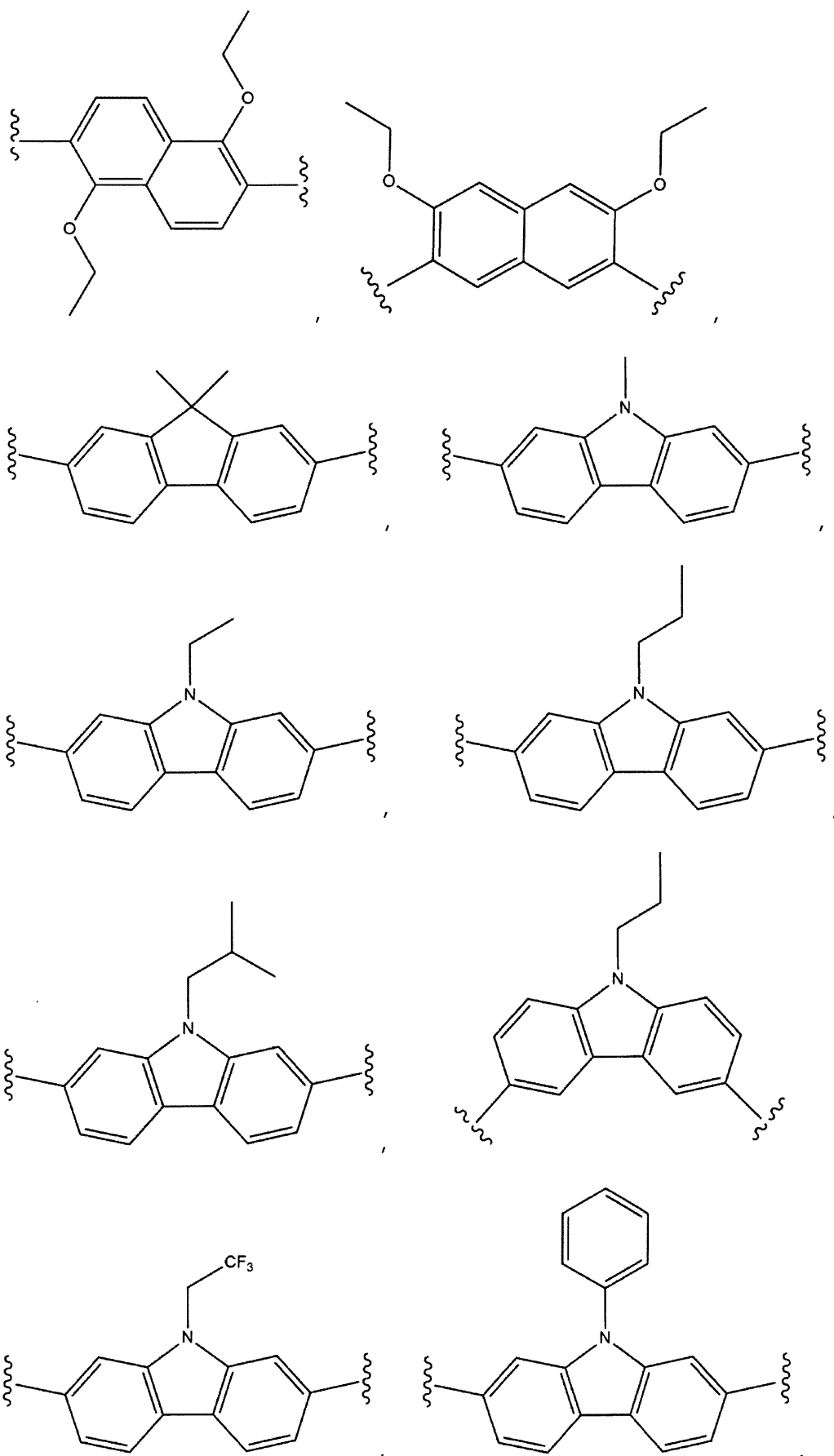


A particularly preferred embodiment of the present invention relates to the compound of the invention where the conjugated D¹ to D³ blocks are each independently selected from the group of the following structural units:

5







The inventors of the present invention have observed that compounds having one of these conjugated blocks for D¹ to D³ have unexpectedly high absorption in the short-wave range, particularly for wavelengths less than 500 nm, which generally distinctly exceed the absorption of
5 conventional compounds.

The present invention relates not only to the compound of the invention but additionally to the use of the compound of the invention in a photoactive organic electronic component.

Photoactive organic electronic components convert electromagnetic
10 radiation to electrical energy. This principle is applied in various kinds of photoactive organic electronic component. The use of compounds of the invention that exhibit particularly high absorption over the entire wavelength range of visible light and additionally utilize short-wave visible light (about 400 to 600 nm) more
15 effectively than conventional organic compounds, merely owing to their excellent absorption properties, are already of excellent suitability for use in photoactive organic electronic components. High-energy photons can also be absorbed and hence trigger electron transitions. Since the compounds of the invention can better absorb
20 higher-energy photons, they utilize the short-wave spectrum of visible light more efficiently. With the use of the compound of the invention, it is thus possible to improve the efficiency and sensitivity of photoactive organic electronic components.

For instance, in the case of photodetectors that utilize the
25 compounds of the invention, better sensitivity may be enabled than in the case of comparable photodetectors with conventional organic compounds that do not exhibit the favorable absorption properties of the compound of the invention. For example, the compounds of the invention, as well as photodetectors, can also be used for light-
30 sensitive field-effect transistors. Use in the field of photoconductors for printing and copying machines is also conceivable.

Analogously, it is also possible in other photoactive organic electronic components to enhance sensitivity or efficiency through the use of the compounds of the invention.

It is most preferable here to use the compound of the invention in a photoactive organic electronic component which is an organic solar cell. The efficient utilization of visible light with short wavelengths as well with the compounds of the invention makes it
5 possible to produce organic solar cells with a higher efficiency than solar cells based on the basis of organic compounds that do not feature these favorable absorption properties.

Moreover, the compounds of the invention also have adequate charge carrier transport properties that make them suitable for use in
10 photoactive organic electronic components in general and for organic solar cells in particular.

The present invention also relates to a photoactive organic electronic component comprising the compound of the invention.

As just described, the inventors of the present invention have found
15 that the compounds of the invention, owing to their absorption properties, are of excellent suitability for use in photoactive organic electronic components.

In a preferred embodiment, the photoactive organic electronic component has a photoactive layer, for example a light-sensitive
20 layer comprising the compound of the invention.

In a further embodiment, the photoactive organic electronic component has at least two electrodes between which the photoactive layer is disposed.

In a further embodiment, the component has further layers, especially
25 charge transport layers, for instance electron transport layers and hole transport layers.

In a further embodiment, the component has a substrate. More particularly, one of the electrodes of the component may be mounted on the substrate.

30 In a further embodiment, the photoactive organic electronic component comprises organic solar cells, photodetectors, solution-processed solar cells, xerographic layers, photoconductors for printing or copying machines.

In a particularly preferred embodiment, the photoactive organic electronic component is an organic solar cell. Solar cells comprising the compound of the invention enable particularly efficient utilization of the short-wave spectrum of visible light.

5 In a development of the organic solar cell just described, the organic solar cell has a photoactive region having at least one organic donor material in contact with at least one organic acceptor material, wherein the donor material and the acceptor material form a donor-acceptor heterojunction, specifically also what is called a
10 bulk heterojunction (BHJ), and wherein the photoactive region comprises at least one compound of the formula I.

For example, the compound of the invention can be used a standard setup of organic solar cells as described in the literature.

A setup already known from the literature for a standard organic
15 solar cell consists, for example, in pin or nip diodes [Martin Pfeiffer, "Controlled doping of organic vacuum deposited dye layers: basics and applications", PhD thesis TU-Dresden, 1999 and WO 2011 161 108]: a pin solar cell consists here of a carrier/substrate with an adjoining, usually transparent base contact, p layer(s), i layer(s),
20 n layer(s) and a top contact. A nip solar cell consists of a carrier/substrate with an adjoining, usually transparent base contact, n layer(s), i layer(s), p layer(s) and a top contact.

Means here that n or p doping leads to an increase in the density of free electrons/holes in the thermal equilibrium state. Thus, layers
25 of this kind should be regarded primarily as transport layers. It is also possible that n or p layers are at least partly nominally undoped and have preferably electron-conducting or hole-conducting properties only by virtue of the material properties (for example different mobility) or owing to different impurities (for example
30 remaining residues from the synthesis or the layer production) or through environmental influences (for example adjoining layers, inward diffusion of metals or other organic materials, gas doping from the surrounding atmosphere). In this context, layers of this kind should preferably be regarded as transport layers.

The excitons arrive via diffusion at an interface of this kind, where electrons and holes are separated from one another. The material that accepts the electrons is referred to as acceptor, and the material that absorbs the holes as donor.

5 The term "i layer" characterizes an undoped or intrinsic layer. One or more i layers may consist of one material (planar heterojunctions, PHJs) or of a mixture of two or more materials, called bulk heterojunctions (BHJs), which have an interpenetrating network.

Also known from the literature are organic pin tandem cells and pin
10 multiple cells DE 10 2004 014 046. In this regard, WO 2011 161 108 A1 discloses a proposal for implementation in the form of a photoactive component with an electrode and a counterelectrode, wherein at least one organic layer system is disposed between the electrodes, and also with at least two photoactive layer systems and at least two
15 different transport layer systems of the same charge carrier type between the photoactive layer systems, characterized in that one transport layer system is matched in terms of energy to one of the two photoactive layer systems and the other transport layer system is transparent.

20 The layers of the invention may especially be used as absorber material in said types of photoactive organic electronic components or in similar, commonly known photoactive organic electronic components in the respective absorber layer.

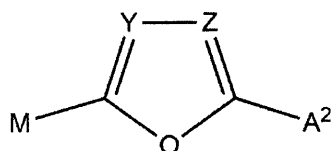
In a further embodiment, the photoactive organic electronic component
25 is a single cell, a tandem cell, triple cell, quadruple cell or another multiple cell. "Tandem cell" in the present application is understood to mean that two functional cells are stacked one on top of another in spatial terms and are connected in series, where one or more interlayers may be arranged between the cells. A multiple cell
30 or multi-junction cell is likewise understood to mean that more than two functional cells are stacked one on top of another in spatial terms and are connected in series, where an interlayer may be arranged between the cells.

Preferably, the component consists of a combination of nip, ni, ip,
35 pnip, pni, pip, nipn, nin, ipn, pnipn, pnin or pipn structures which

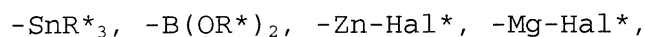
of the multiple independent combinations containing at least one i layer are stacked one on top of another.

In a further development, the photoactive organic electronic component of the invention is a component including at least one
5 layer comprising the compound of the invention, wherein the compound of the invention and/or said layer is deposited by means of vacuum processing, gas phase deposition or solution processing.

The invention additionally relates to a compound for the preparation of the compound of the invention, having the following general
10 formula:



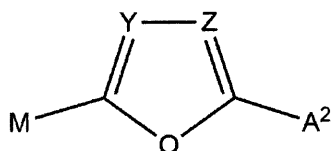
where Y, Z and A² are as defined in any of the preceding claims and where M is selected from one of the following functional groups:



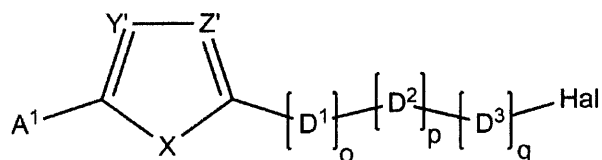
15 where R* is a C₁-C₁₀-alkyl and where the Hal* group is a halogen. Halogen means F, Cl, Br and I, preferably Cl, Br and I.

The compound is an important starting material for the preparation of the inventive compound as claimed in claim 1.

The invention further relates to a process for preparing the compound
20 of the invention. The process comprises, as a process step, a coupling reaction in which the compound of the general formula just described

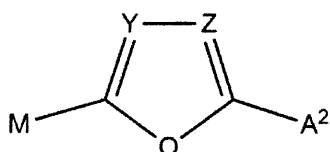


reacts with a further compound of the following general formula

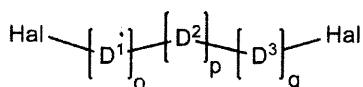


A^1 , Y' , Z' , X , D^1 to D^3 and o , p and q are defined for the further compound as described for the compound of the invention. The Hal group is additionally a halogen. This may be F, Cl, Br and I, preferably Cl, Br and I, especially Br and I.

- 5 In a further embodiment of the process of the invention, the process comprises a coupling reaction in which two equivalents of the described compound having the general formula



react with a further compound of the general formula



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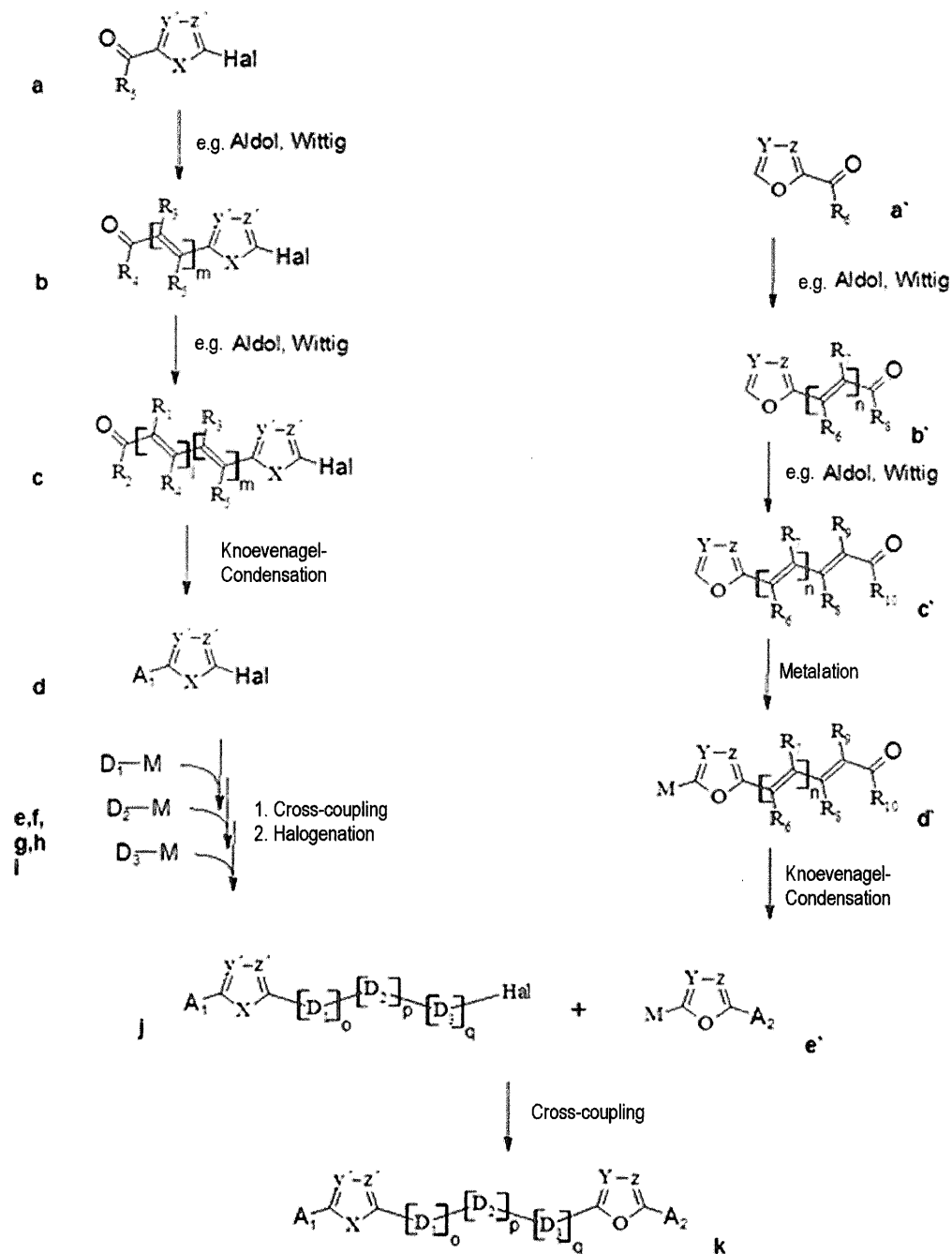
by means of which it is possible, by a simplified route, to prepare mirror-symmetric compounds of the invention in which $X = O$, $Y = Y'$, $Z = Z'$ and $A^1 = A^2$.

The inventors of the present invention have found that the compounds
15 of the invention are obtainable by means of coupling reactions in good yields and selectivities with acceptable experimental work.

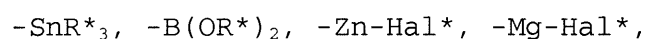
In a preferred embodiment of the process of the invention, Pd-based catalysts are used in the coupling reaction. An example of particularly good suitability is $\text{Pd}(\text{PPh}_3)_4$.

- 20 Preferably, the coupling reaction in the process of the invention is a reaction selected from the group of the following coupling reactions: Stille coupling, Negishi coupling and Suzuki coupling. These coupling reactions have been found to be particularly suitable for the synthesis of the compounds of the invention.
- 25 The synthesis of the compounds of the invention is to be elucidated hereinafter in general and more particularly with reference to a number of specific examples. Advantageously, the compounds of the invention can be made available by a simple building block system easily and in good yields.

The schematic diagram below is a simplified representation of a synthesis route for compounds of the invention. The letter k here identifies a compound of the invention:



5 M may be selected here, for example, from one of the following functional groups:



where R* is a C₁-C₁₀-alkyl and where the Hal* group is a halogen (F, Cl, Br, I). The abbreviation Hal also represents a halogen selected from F, Cl, Br, I.

Compound **a** is commercially available, or can be prepared from
5 commercially available synthons by the person skilled in the art by means of known methods (halogenation, acetylation or carbonylation). The conversion to **b** can be effected, for example, by an aldol reaction or Wittig reaction or other typical reactions for the generation of a double bond from a carbonyl function. The direct
10 preparation of **b** from non-halogenated (hetero-)aromatic components, for example by Heck reaction, is also possible. For preparation of compound **c**, this step can be repeated as often as desired. Compound **d** can be prepared, for example, by a Knoevenagel condensation with a compound bearing a methylene unit. In a series of cross-coupling
15 reactions repeatable as often as desired, for example Suzuki, Negishi or Stille couplings and variants thereof, with subsequent introduction of a halogen atom (especially Cl, Br or I), the structural units D¹ to D³ are incorporated into the structure of the compound. In this way, the intermediates **e-j** are obtained. Rather
20 than the use of the metalated structural units D¹ to D³, the use of non-metalated units D¹ to D³, or of differently activated units D¹ to D³, is likewise conceivable.

Compound **a'** is commercially available, or can be prepared from commercially available synthons by methods known to those skilled in
25 the art for acetylation or carbonylation. The conversion to **b'** can be effected, for example, by aldol reaction or Wittig reaction or other typical syntheses for generation of a double bond from a carbonyl function. For preparation of compound **c'**, this step can be repeated as often as desired. The direct preparation of **b'** or **c'** from an
30 unsubstituted (hetero-)aromatic, for example by Heck reaction, or reaction with unsaturated dialkylamino-substituted carbonyls is also possible. The coupling of **d'** can be effected by metalation of compound **c'**. In this reaction, the carbonyl function can be intermediately protected. Compound **e'** can be prepared, for example,
35 by Knoevenagel condensation with a compound bearing a methylene unit. By a typical cross-coupling reaction, for example Suzuki, Negishi or

Stille coupling and the variants thereof, a component of the **j** type can be reacted with a component of the **e'** type to give the claimed compounds of the **k** type.

In the presence of a mirror plane at right angles to the longitudinal axis of the molecule, the synthesis can be correspondingly simplified owing to the symmetric molecular structure.

In principle, in all C-C coupling reactions, the reversal of the metal and halogen functionalities is conceivable, as is the use of different functional groups on either side, for example, but without limitation, sulfonates, triflates and carboxylic acids, or non-activated species called C-H-activated species. In general, but not exclusively, the C-C cross-coupling reactions are effected with use of a catalyst.

Among other compounds, corresponding bromide compounds and stannyl compounds have been synthesized from their precursor molecules and then converted to compounds of the invention. Three different routes are to be illustrated by way of example hereinafter.

Coupling by means of a

- a. double inverse Stille coupling,
- 20 b. double Stille coupling or
- c. single Stille coupling.

Also analogously suitable are further coupling reactions known from the literature, for example the Heck reaction or Kumada coupling. Suzuki, Negishi or Stille, Kumada or Hiyama and further coupling reactions are described, inter alia, in "Metal-Catalyzed Cross-Coupling Reactions, 2nd, Completely Revised and Enlarged Edition" (Wiley VCH, ISBN: 978-3-527-30518-6) (Suzuki: pages 41-123, Negishi: pages 619-670, Stille: pages 125-161, Kumada: pages 671-698, Hiyama: pages 163-216, further coupling reactions: pages 815-889).

30

Detailed hereinafter are the corresponding general procedures (GP1 to GP3) for versions a, b and c:

a) General procedure (GP1)

1 mmol of dibromo compound (reactant 1) and 2.5 mmol of 2-[(E)-3-(5-trimethylstannanylfuran-2-yl)allylidene]malononitrile **B4** (reactant 2) were dissolved in 4 mL of appropriate solvent (tab. 1) and the solution was degassed. Then 0.05 mmol of Pd catalyst was added and the reaction mixture was heated overnight. The reaction mixture was brought to room temperature, and solids that precipitated out were filtered off and washed with methanol. The crude product was recrystallized from appropriate solvent (tab. 1).

No.	Reactant 1	Reactant 2	Reaction conditions	Yield (%)	Recrystallized from
1	A11	B4	Pd(PPh ₃) ₄ /DMF (N,N-dimethylformamide)/80°C	75	toluene
2	A21	B4	Pd ₂ dba ₃ / P(t-Bu) ₃ ·HBF ₄ / toluene/110°C	55	chloro-benzene
3	A20	B4	Pd(PPh ₃) ₄ /chloro-benzene/ 136°C	38	chloro-benzene
4	A9	B4	Pd(PPh ₃) ₄ /dioxane/80°C	34	chloro-benzene
5	A12	B4	Pd(PPh ₃) ₄ /dioxane/80°C	71	chloro-benzene
8	A6	B4	Pd(PPh ₃) ₄ /dioxane/80°C	41	chloro-benzene
10	A7	B4	Pd(PPh ₃) ₄ /dioxane/80°C	52	chloro-benzene
12	A3	B4	Pd(PPh ₃) ₄ /DMF/80°C	21	toluene
20	A24	B4	Pd(PPh ₃) ₄ /DMF/80°C	18	chloro-benzene
18	A23	B4	Pd(PPh ₃) ₄ /DMF/80°C	23	toluene
19	A5	B4	Pd(PPh ₃) ₄ /DMF/80°C	10	toluene
25	A22	B4	Pd(PPh ₃) ₄ /toluene/110°C	57	chloro-benzene
27	A2	B4	Pd(PPh ₃) ₄ /dioxane/80°C	27	chloro-benzene

No.	Reactant 1	Reactant 2	Reaction conditions	Yield (%)	Recrystallized from
28	A10	B4	P(PPh ₃) ₄ /dioxane/80°C	35	chloro-benzene
29	A18	B4	Pd(PPh ₃) ₄ /dioxane/80°C	66	chloro-benzene
31	A26	B4	Pd-PEPPSI-IPent/CsF/dioxane/80°C	13	chloro-benzene
30	A25	B4	Pd ₂ dba ₃ / P(t-Bu) ₃ / dioxane/80°C	64	chloro-benzene
33	A28	B4	Pd ₂ dba ₃ / P(t-Bu) ₃ / dioxane/80°C	52	chloro-benzene
35	A30	B4	Pd ₂ dba ₃ / P(t-Bu) ₃ / dioxane/80°C	49	chloro-benzene
36	A31	B4	Pd ₂ dba ₃ / P(t-Bu) ₃ / dioxane/80°C	16	chloro-benzene
38	A35	B4	Pd ₂ dba ₃ / P(t-Bu) ₃ / dioxane/80°C	48	chloro-benzene
39	A34	B4	Pd ₂ dba ₃ / P(t-Bu) ₃ / dioxane/80°C	68	chloro-benzene
40	A36	B4	Pd ₂ dba ₃ / P(t-Bu) ₃ / dioxane/80°C	14	chloro-benzene
41	A37	B4	Pd ₂ dba ₃ / P(t-Bu) ₃ / dioxane/80°C	61	chloro-benzene
42	A33	B4	Pd ₂ dba ₃ / P(t-Bu) ₃ / dioxane/80°C	47	chloro-benzene
47	A39	B4	Pd(t-Bu) ₃ / dioxane/80°C	70	chloro-benzene

Table 1: Reaction conditionsb) General procedure (GP2)

1 mmol of distannyl compound (reactant 1) and 2.5 mmol of bromofuran-2-ylallylidenemalononitrile **B2**, or **B6**, or **B10**, or **B12**, or **B14**, or **B16** (reactant 2) were dissolved in 4 mL of appropriate solvent (tab. 2), and the solution was degassed. Subsequently, 0.05 mmol of Pd catalyst was added and the reaction mixture was heated overnight.

The reaction mixture was brought to room temperature, and solids that precipitated out were filtered off and washed with methanol. The crude product was recrystallized from appropriate solvent (tab. 2).

No.	Reactant 1	Reactant 2	Reaction conditions	Yield (%)	Recrystallized from
6	A4	B16	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	42	chlorobenzene
7	A1	B16	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	46	chlorobenzene
9	A8	B2	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	42	chlorobenzene
11	A14	B2	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	46	chlorobenzene
13	A4	B14	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	42	chlorobenzene
14	A19	B2	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	55	chlorobenzene
15	A1	B14	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	36	chlorobenzene
16	A1	B6	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	52	chlorobenzene
17	A13	B2	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	32	chlorobenzene
22	A1	B10	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	41	chlorobenzene
23	A1	B2	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	37	chlorobenzene
24	A4	B2	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	34	chlorobenzene
26	A1	B12	$\text{Pd}(\text{PPh}_3)_4/\text{DMF}/80^\circ\text{C}$	9	chlorobenzene
32	A27	B2	$\text{Pd}(\text{PPh}_3)_4/1,4\text{-dioxane}/100^\circ\text{C}$	38	toluene
37	A32	B6	$\text{Pd}(\text{PPh}_3)_4/1,4\text{-dioxane}/80^\circ\text{C}$	14	tetrahydrofuran

Table 2: Reaction conditions

5 c) General procedure (GP3)

In an argon-inertized Schlenk vessel, 1 mmol of halogen compound (reactant 1) and 1.2 mmol of 2-[3-(5-trimethylstannanyl-furan-2-yl)-allylidene]malononitrile **B4** (reactant 2) were dissolved in 3 mL of solvent (tab. 3). The solution was degassed, then 0.05 mmol of Pd catalyst was added and the reaction mixture was heated while stirring overnight. The reaction mixture was cooled down to room temperature, and the resultant precipitate was filtered off and washed with methanol. The crude product was recrystallized from the respective solvent (tab. 3).

No.	Reactant 3	Reactant 2	Reaction conditions	Yield (%)	Recrystallized from
21	C2	B4	Pd(PPh ₃) ₄ , tetrahydrofuran, 65°C	24	chloro-benzene
34	C8	B4	Pd(PPh ₃) ₄ , 1,4-dioxane, 100°C	14	chloro-benzene
40	C6	B4	Pd2dba3 / P(t-Bu) ₃ / dioxane/80°C	72	chloro-benzene

Table 3: Reaction conditions

Alternatively, compounds of the invention can also be effected via other known alkyl coupling reactions, for example Suzuki or Negishi reaction.

5

Synthesis of the reactants

The reactants 1 (A), reactants 2 (B) and reactant 3 (C) are synthesized by the following methods:

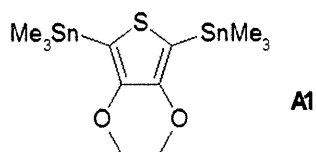
Synthesis of the reactants A

- 10 It is possible to prepare the corresponding stannyl compounds from the appropriately substituted or unsubstituted thiophenes, for example with *tert*-BuLi and trimethyltin chloride. For instance, tin(IV) halides, in the case of reaction with organometallic compounds, such as Grignard reagents, react to give the corresponding
- 15 tin organyls. Organotin halides are usually obtained from tetraorganotin compounds by electrophilic substitution.

The bromides can be prepared by many reactions known from the literature (for example with potassium bromate and hydrogen bromide); analogously, reaction by a method proceeding from the corresponding

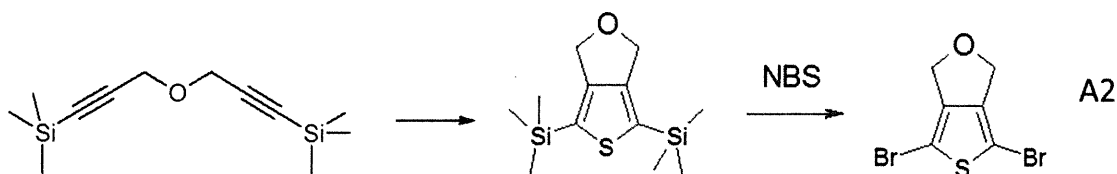
20 trimethylsilyl compound with *N*-bromosuccinimide is also conceivable.

5,7-Bis(trimethylstannyl)-2,3-dihydrothieno[3,4-b][1,4]dioxin (A1)



Compound **A1** was synthesized in accordance with J. Mater. Chem. 1999, 2189.

4,6-Dibromo-1*H*,3*H*-thieno[3,4-*c*]furan (A2)



5 4,6-Bis(trimethylsilyl)-1*H*,3*H*-thieno[3,4-*c*]furan

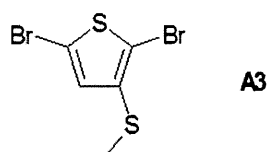
1.92 g (8.27 mmol) of bis(3-trimethylsilyl-2-propynyl) ether and 5.70 g (19.8 mmol) of titanium(IV) isopropoxide were dissolved in 110 mL of diethyl ether under an argon atmosphere at -70°C. 19.8 mL (39.7 mmol) of a 2M isopropylmagnesium chloride solution in diethyl
 10 ether were added dropwise. After stirring at -70°C for 15 min, the mixture was warmed to -50°C and stirred for a further 3.5 h. 2.12 g (66.2 mmol) of sulfur were added in portions and then the reaction mixture was warmed to RT (room temperature) within 16 h. A 1N HCl solution (90 mL) was added and the aqueous phase was extracted three
 15 times with hexane. The combined organic phases were washed with sat. Na₂CO₃ solution and sat. NaCl solution. They were dried over Na₂SO₄ and filtered, and the solvents were removed under reduced pressure. The crude product was purified by chromatography (SiO₂, R_f (DCM (dichloromethane)) = 0.88), and 1.87 g of product (84%) were obtained
 20 as a brown oil. ¹H NMR (CDCl₃): 4.83 ppm (s, 4H), 0.28 (s, 18H).

4,6-Dibromo-1*H*,3*H*-thieno[3,4-*c*]furan (A2)

1.87 g (6.92 mmol) of 4,6-bis(trimethylsilyl)-1*H*,3*H*-thieno[3,4-*c*]furan were dissolved in 18 mL of DMF at 0°C under an argon atmosphere. 2.77 g (15.2 mmol) of NBS (N-bromosuccinimide) dissolved
 25 16 mL of DMF were added and the mixture was stirred at 0°C for 1 h. It was warmed to RT and stirred for a further 16 h. 50 mL of water were added to the reaction mixture, which was extracted twice with MTBE (methyl tert-butyl ether). The combined organic phases were washed with 5% LiCl solution and sat. NaCl solution. They were dried
 30 over Na₂SO₄ and filtered, and the solvents were removed under reduced

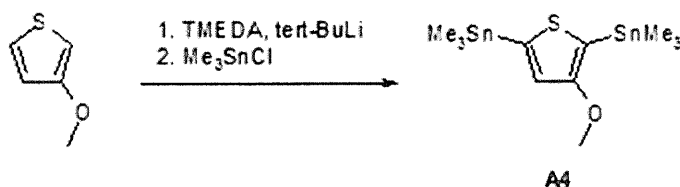
pressure. The residue was purified by chromatography (SiO_2 , PE:DCM (2:1), $R_f = 0.54$), and 703 mg of product **A2** (36%) were obtained as a yellow oil. ^1H NMR (CDCl_3): 4.75 ppm (s, 4H).

2,5-Dibromo-3-thiomethylthiophene (A3)

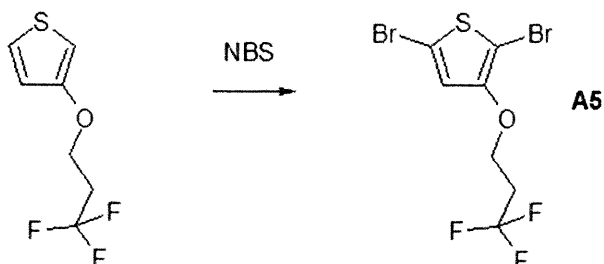


Compound **A3** was prepared according to M. Lanzi et al. *Reactive & Functional Polymers* 2014 (83) 33-41.

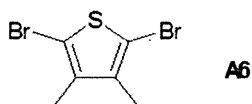
2,5-Bis(trimethylstannyl)-3-methoxythiophene (A4)



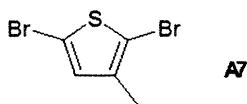
To a solution of 3-methoxythiophene (342 mg, 3.00 mmol) and N,N,N',N'-tetramethylethylenediamine (1.05 g, 9.00 mmol) in hexane (50 mL) was added dropwise, at -78°C under an argon atmosphere, *tert*-butyllithium solution (1.48 M in hexane, 6.10 mL, 9.00 mmol). The reaction mixture was stirred at -65°C for 10 min, warmed to room temperature and stirred for a further 4.5 h. Subsequently, the reaction solution was cooled down to -65°C , trimethyltin chloride solution (1M in tetrahydrofuran, 9 mL, 9.00 mmol) was added, and the mixture was warmed to room temperature in a cooling bath overnight, poured onto water (40 mL) and extracted with hexane (3 x 30 mL). The combined organic phases were washed with saturated ammonium chloride solution (2 x 30 mL), hydrochloric acid (1M, 4 x 30 mL) and water (30 mL), dried over sodium sulfate and filtered. The removal of the solvent under reduced pressure gave crude 3-methoxy-2,5-bis-(trimethylstannanyl)thiophene (1.18 g, 2.58 mmol, 86%) as a colorless viscous oil, which was used in the next reaction step without further purification. ^1H NMR (CDCl_3): 7.04 ppm (s, 1H), 3.83 (s, 3H), 0.35 (s, 9H), 0.33 (s, 9H).

2,5-Dibromo-3-(3,3,3-trifluoropropoxy)thiophene (A5)

432 mg (2.20 mmol) of 3-(3,3,3-trifluoropropoxy)thiophene (synthesis analogous to A18a) were dissolved in 5 mL of dry DMF at 0°C under argon. 1.03 g (5.72 mmol) of NBS were added in small portions and the mixture was stirred at 0°C for 1 h. Once the cooling bath had been removed, the reaction mixture was stirred at room temperature for 24 h. The reaction mixture was admixed with water and extracted twice with 20 mL of MTBE. The organic phase was dried over sodium sulfate. The solvents were removed on a rotary evaporator and the residue was chromatographed using silica gel in ethyl acetate/petroleum ether 1/9. This gave 319 mg of **A5**. EI-MS, m/z 353.89 [M]. ^1H NMR (CDCl₃) ppm: 6.77 (s, 1H), 4.22 (t, 2H), 2.61 (m, 2H).

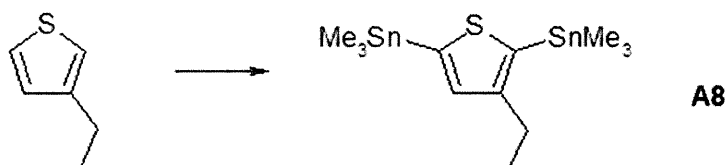
2,5-Dibromo-3,4-dimethylthiophene (A6)

Compound **A6** was prepared according to Yasuyuki Kiya, Jay C. Henderson, Geoffrey R. Hutchison, Héctor D. Abruña J. Mater. Chem. 2007, 17, 4366-4376.

2,5-Dibromo-3-methylthiophene (A7)

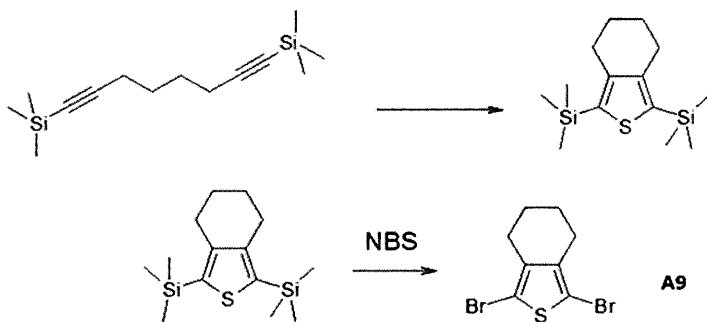
A7 is commercially available.

3-Ethyl-2,5-bis(trimethylstannyl)thiophene (A8)



To a solution of 224 mg (2.00 mmol) of 3-ethylthiophene in 10 mL of dry *n*-hexane and 0.85 mL of TMEDA (N,N,N,N-tetramethylethylenediamine) were added dropwise 5.0 mL (8.00 mmol) of 1.6 M *n*-butyllithium in *n*-hexane at -78°C. After stirring at -78°C for 10 min., the cooling bath was removed and the reaction mixture was stirred at R.T. for 20 h. The suspension was cooled down again to -78°C and 8.0 mL (8.00 mmol) of a 1.0M trimethylstannyl chloride solution in THF (tetrahydrofuran) were added dropwise. The reaction mixture was stirred at -78°C for 1 h and then at R.T. for 3 h. After addition of 50 mL of *n*-hexane, hydrolysis was effected with water. The organic phase was washed three times with 50 mL of water and dried over sodium sulfate. After the solvents had been removed, the residue was dried under reduced pressure. The crude product (869 mg, 99%) was used in the next stage without further purification steps. ¹H NMR (CDCl₃): 7.21 ppm (s, 1H), 2.71 (q, 2H), 1.24 (t, 3H), 0.37 (s, 9H), 0.35 (s, 9H).

1,3-Dibromo-4,5,6,7-tetrahydrobenzo[*c*]thiophene (A9)



20

1,3-Bis(trimethylsilyl)-4,5,6,7-tetrahydrobenzo[*c*]thiophene

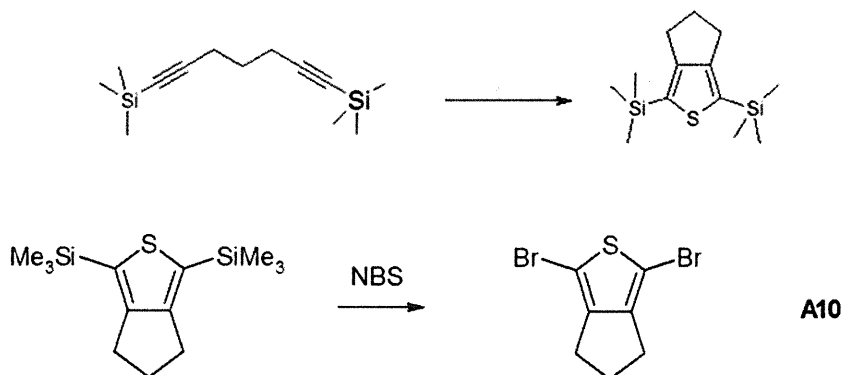
7.13 g (28.5 mmol) of 1,8-bis(trimethylsilyl)octa-1,7-diyne and 19.6 g (68.4 mmol) of titanium(IV) isopropoxide were dissolved in 380 mL of diethyl ether under an argon atmosphere at -70°C. 68.4 mL (137 mmol) of a 2M isopropylmagnesium chloride solution in diethyl

ether were added dropwise. After stirring at -70°C for 15 min, the mixture was warmed to -50°C and stirred for a further 3.5 h. 7.31 g (228 mmol) of sulfur were added in portions and then the reaction mixture was warmed to RT within 16 h. A 1N HCl solution (300 mL) was added and the aqueous phase was extracted three times with hexane. The combined organic phases were washed with sat. Na_2CO_3 solution and sat. NaCl solution. They were dried over Na_2SO_4 and filtered, and the solvents were removed under reduced pressure. The residue was purified by chromatography (SiO_2 , PE, $R_f = 0.74$), and 5.20 g (18.4 mmol) of product (65%) were obtained as a pale yellow oil. ^1H NMR (CDCl_3): 2.80 ppm (m, 4H), 1.76 (m, 4H), 0.31 (s, 18H).

1,3-Dibromo-4,5,6,7-tetrahydrobenzo[c]thiophene (A9)

4.35 g (15.4 mmol) of 1,3-bis(trimethylsilanyl)-4,5,6,7-tetrahydrobenzo[c]thiophene were dissolved in 40 mL of DMF at 0°C under an argon atmosphere. 6.09 g (33.9 mmol) of NBS dissolved in 37 mL of DMF were added and the mixture was stirred at 0°C for 1 h. The mixture was warmed to RT and stirred for a further 16 h. 200 mL of water were added to the reaction mixture, which was extracted twice with MTBE. The combined organic phases were washed with 2N NaOH solution, 5% LiCl solution and sat. NaCl solution. They were dried over Na_2SO_4 and filtered, and the solvents were removed under reduced pressure. The residue was purified by chromatography (SiO_2 , PE, $R_f = 0.73$), and 4.31 g of product **A9** (79%) were obtained as a pale yellow oil. ^1H NMR (CDCl_3): 2.50 ppm (m, 4H), 1.72 (m, 4H).

1,3-Dibromo-5,6-dihydro-4H-cyclopenta[c]thiophene (A10)

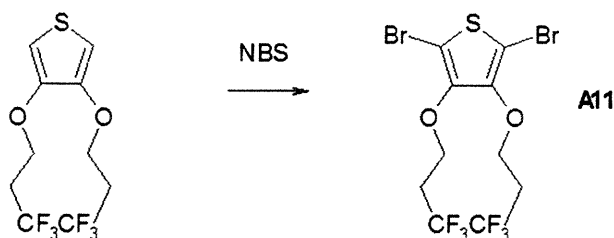


1,3-Bis(trimethylsilyl)-5,6-dihydro-4H-cyclopenta[c]thiophene
(A10a)

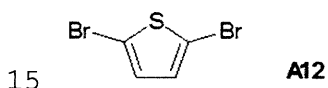
2.37 g (10.0 mmol) of 1,7-bis(trimethylsilyl)hepta-1,6-diyne and
6.91 g (24.0 mmol) of titanium(IV) isopropoxide were dissolved in
5 130 mL of diethyl ether under an argon atmosphere at -70°C. 24.0 mL
(48.0 mmol) of a 2M isopropylmagnesium chloride solution in diethyl
ether were added dropwise. After stirring at -70°C for 15 min, the
mixture was warmed to -50°C and stirred for a further 3.5 h. 2.57 g
(80.0 mmol) of sulfur were added in portions and then the reaction
10 mixture was warmed to RT within 16 h. A 1N HCl solution (105 mL) was
added and the aqueous phase was extracted three times with hexane.
The combined organic phases were washed with sat. Na₂CO₃ solution and
sat. NaCl solution. They were dried over Na₂SO₄ and filtered, and the
solvents were removed under reduced pressure. The crude product was
15 purified by chromatography (SiO₂, R_f (PE)= 0.63), and 2.38 g of
product (89%) were obtained as a pale yellow oil. ¹H NMR (CDCl₃): 2.69
ppm (t, 4H), 2.43(m, 2H), 0.30 (s, 18H).

1,3-Dibromo-5,6-dihydro-4H-cyclopenta[c]thiophene (A10)

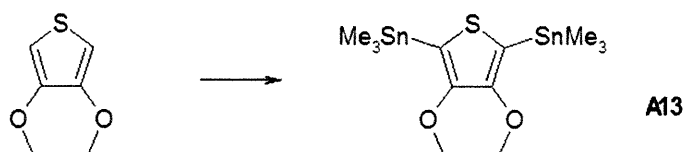
2.38 g (8.88 mmol) of 1,3-bis(trimethylsilyl)-5,6-dihydro-4H-
20 cyclopenta[c]thiophene were dissolved in 22 mL of DMF at 0°C under an
argon atmosphere. 3.19 g (17.8 mmol) of NBS dissolved 20 mL of DMF
were added and the mixture was stirred at 0°C for 1 h. It was warmed
to RT and stirred for a further 16 h. 50 mL of water were added to
the reaction mixture, which was extracted twice with MTBE. The
25 combined organic phases were washed with 5% LiCl solution and sat.
NaCl solution. They were dried over Na₂SO₄ and filtered, and the
solvents were removed under reduced pressure. The residue was
purified by chromatography (SiO₂, PE, R_f = 0.54), and 1.25 g of
product **A10** (50%) were obtained as a colorless oil. ¹H NMR (CDCl₃):
30 2.62 ppm (t, 4H), 2.37 (m, 2H).

2,5-Dibromo-3,4-bis(3,3,3-trifluoropropoxy)thiophene (A11)

2.75 g (8.9 mmol) of 3,4-bis(3,3,3-trifluoropropoxy)thiophene (synthesis analogous to A18a) were dissolved in 33 mL of dry DMF and cooled down to 0°C. 3.21 g (17.8 mmol) of NBS were added in small portions and the reaction mixture was stirred at room temperature overnight. Subsequently, the reaction mixture was added to 100 mL of ice-water. The aqueous phase was extracted three times with 100 mL of DCM. The organic phase was washed three times with 100 mL of sat. NaCl and dried over sodium sulfate. The solvents were removed on a rotary evaporator and the residue was purified via chromatography (SiO₂, DCM/petroleum ether 1/9). This gave 2.20 g of **A11**. EI-MS, *m/z* 465.82 [M].

2,5-Dibromothiophene (A12)

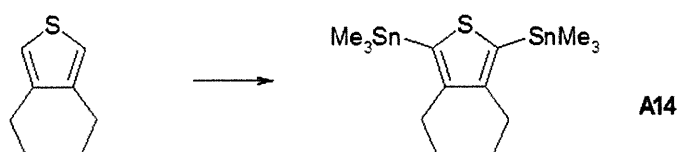
A12 is commercially available.

3,4-Dimethoxy-2,5-bis(trimethylstannanyl)thiophene (A13)

To a solution of 288 mg (2.00 mmol) of 3,4-dimethoxythiophene in 10 mL of dry *n*-hexane and 0.85 mL of TMEDA were added dropwise, at -78°C, 4.05 mL (6.08 mmol) of a 1.5 M *tert*-butyllithium solution in *n*-pentane. The mixture was stirred at -78°C for 10 min and at R.T. for a further 3.5 h. The resultant suspension was cooled down again to -78°C, and 6.0 mL (6.00 mmol) of a 1.0 M trimethylstannyl chloride solution in THF were added dropwise. The reaction mixture was stirred at -78°C for 1 h and at R.T. for a further 16 h. Subsequently, 50 mL

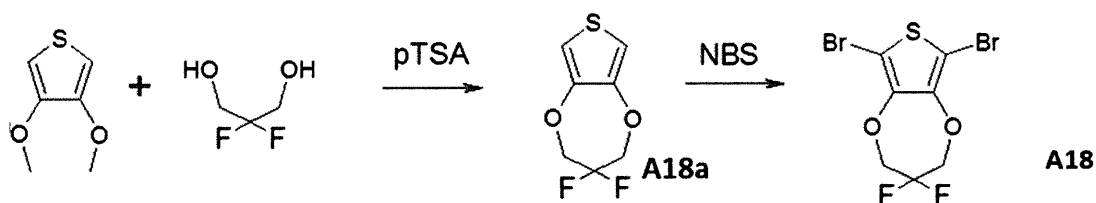
of *n*-hexane were added and hydrolysis was effected with water. The organic phase was removed, washed three times with 50 mL of water and dried over sodium sulfate. After the removal of the solvents, the residue was dried under reduced pressure (681 mg, 72%). ¹H NMR (acetone-d₆): 3.77 ppm (s, 6H), 0.34 (s, 18H).

3,4-Diethyl-2,5-bis(trimethylstannyl)thiophene (A14)



To a solution of 280 mg (2.00 mmol) of 3,4-diethylthiophene in 10 mL of dry *n*-hexane and 0.85 mL of TMEDA were added dropwise, at -78°C, 2.4 mL (6.00 mmol) of a 2.5 M *n*-butyllithium solution in *n*-hexane. The mixture was stirred at -78°C for 10 min and at R.T. for a further 20 h. The resultant suspension was cooled down again to -78°C, and 6.0 mL (6.00 mmol) of a 1.0 M trimethylstannyl chloride solution in THF were added dropwise. The reaction mixture was stirred at -78°C for 1 h and at R.T. for a further 3 h. Subsequently, 50 mL of *n*-hexane were added and hydrolysis was effected with water. The organic phase was removed, washed three times with 50 mL of water and dried over sodium sulfate. After the removal of the solvents, the residue was dried under reduced pressure (887 mg, 95%). ¹H NMR (CDCl₃): 2.66 ppm (q, 4H), 1.17 (t, 6H), 0.36 (s, 18H).

6,8-Dibromo-3,3-difluoro-3,4-dihydro-2*H*-thieno[3,4-*b*][1,4]dioxepine (A18)



3,3-Difluoro-3,4-dihydro-2*H*-thieno[3,4-*b*][1,4]dioxepine (A18a)

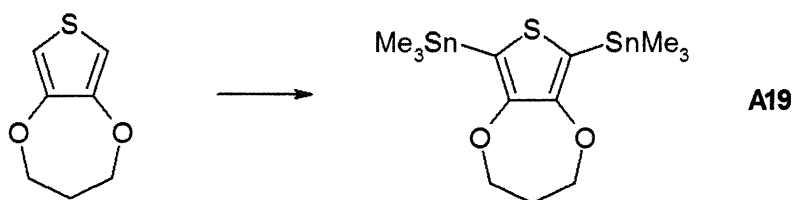
In a Soxhlet apparatus, the extraction thimble was charged with molecular sieve (4Å) and, under an argon atmosphere, 105 mg (0.55 mmol) of *p*-toluenesulfonic acid monohydrate in 52 mL toluene

were heated under reflux for 1 h. The mixture was allowed to cool down to RT, and 787 mg (5.46 mmol) of 3,4-dimethoxythiophene and 1.28 g (10.9 mmol) of 2,2-difluoropropane-1,3-diol were added, and the mixture was heated under reflux for 16 h. Water (50 mL) was added to the reaction mixture, and the aqueous phase was extracted once with toluene. The combined organic phases were washed with sat. NaCl solution. They were dried over Na₂SO₄ and filtered, and the solvents were removed under reduced pressure. The crude product was purified by chromatography using silica gel, and 237 mg of product (23%) were obtained as a colorless oil. ¹H NMR (CDCl₃): 6.58 ppm (s, 2H), 4.30 (t, 4H).

6,8-Dibromo-3,3-difluoro-3,4-dihydro-2H-thieno[3,4-b][1,4]dioxepine (A18)

236 mg (1.23 mmol) of 3,3-difluoro-3,4-dihydro-2H-thieno[3,4-b][1,4]-dioxepine were dissolved in 15 mL of DMF at 0°C under an argon atmosphere. 442 mg (2.46 mmol) of NBS were added at 0°C. The mixture was warmed to RT and stirred for a further 16 h. 30 mL of 5% LiCl solution were added to the reaction mixture, which was extracted three times with DCM. The combined organic phases were washed with 5% LiCl solution and sat. NaCl solution. They were dried over Na₂SO₄ and filtered, and the solvents were removed under reduced pressure. The residue was purified by chromatography using silica gel, and 300 mg of product **A18** (70%) were obtained as a colorless oil. ¹H NMR (CDCl₃): 4.38 ppm (t, 4H).

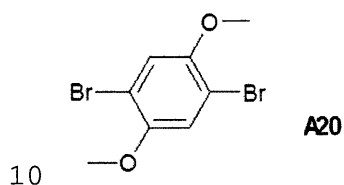
6,8-Bis(trimethylstannyl)-3,4-dihydro-2H-thieno[3,4-b][1,4]dioxepine (A19)



To a solution of 312 mg (2.00 mmol) of 3,4-dihydro-2H-thieno[3,4-b][1,4]dioxepine in 10 mL of *n*-hexane and 0.85 mL of TMEDA were added dropwise 5.33 mL (8.00 mmol) of 1.5 M *tert*-butyllithium solution in *n*-pentane at -78°C. The mixture was stirred at -78°C for 10 min and

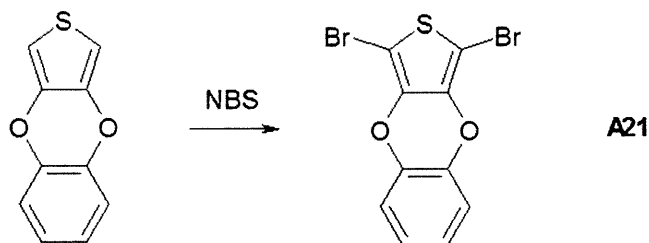
then at RT for 3.5 h. The suspension was cooled to -78°C and 8.0 mL (8.00 mmol) of 1.0M trimethylstannyl chloride solution in THF were added. The reaction mixture was brought to RT overnight, diluted with 20 mL of *n*-hexane and washed with 1N HCl solution and water. The organic phase was dried over Na_2SO_4 and filtered, and the solvents were distilled off under reduced pressure. The residue **A19** (548 mg, 57%) was used in the next stage without further purification. ^1H NMR (CDCl_3): 3.99 ppm (m, 4H), 2.15 (m, 2H), 0.32 (s, 18H).

1,4-Dibromo-2,5-dimethoxybenzene (A20)

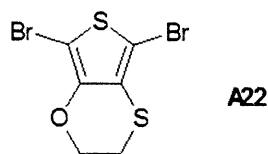


A20 is commercially available.

1,3-Dibromo-4,9-dioxo-2-thiacyclopenta[b]naphthalene (A21)



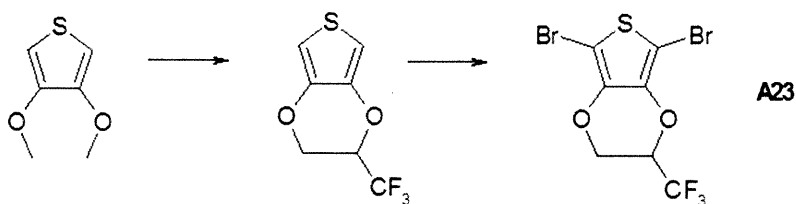
368 mg (1.93 mmol) of 4,9-dioxo-2-thiacyclopenta[b]naphthalene (Roquet, J. Mater. Chem. 2004, 14, 1396-1400) were dissolved in 10 mL of DMF at 0°C under an argon atmosphere. 696 mg (3.87 mmol) of NBS were added and the mixture was stirred at 0°C for 1 h. The mixture was warmed to RT and stirred for a further 16 h. 30 mL of water were added to the reaction mixture, which was extracted three times with DCM. The combined organic phases were washed with sat. $\text{Na}_2\text{S}_2\text{O}_3$ solution and sat. NaCl solution. They were dried over Na_2SO_4 and filtered, and the solvents were removed under reduced pressure. The residue was recrystallized from methanol, and 523 mg of product **A21** (78%) were obtained as a colorless solid. ^1H NMR (CDCl_3): 6.98-7.05 ppm (m, 4H).

1,3-Dibromo-5,6-dihydro-4-oxa-2,7-dithiaindene (A22)

Compound **A22** was synthesized in accordance with compound **A24**.

5,7-Dibromo-2-trifluoromethyl-2,3-dihydrothieno[3,4-b][1,4]dioxin

5 (A23)

2-Trifluoromethyl-2,3-dihydrothieno[3,4-b][1,4]dioxin

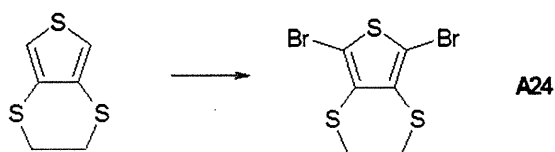
In a Soxhlet apparatus, the extraction thimble was charged with molecular sieve (4Å) and, under an argon atmosphere, 74 mg (0.39 mmol) of p-toluenesulfonic acid monohydrate in 36 mL of toluene were heated under reflux for 1 h. The mixture was allowed to cool down to RT, and 555 mg (3.85 mmol) of 3,4-dimethoxythiophene and 1.00 g (7.70 mmol) of 3,3,3-trifluoropropane-1,2-diol were added and the mixture was heated under reflux for 16 h. Water (50 mL) was added to the reaction mixture and the aqueous phase was extracted once with toluene. The combined organic phases were washed with sat. NaCl solution. They were dried over Na₂SO₄ and filtered, and the solvents were removed under reduced pressure. The crude product was purified by chromatography using silica gel, and 322 mg of product (40%) were obtained as a colorless solid. GC-MS (EI, 75eV) *m/z* 209.9 (*M*⁺, 100%).

5,7-Dibromo-2-trifluoromethyl-2,3-dihydrothieno[3,4-b][1,4]dioxin (A23)

322 mg (1.53 mmol) of 2-trifluoromethyl-2,3-dihydro-thieno[3,4-b]-[1,4]dioxin were dissolved in 15 mL of THF at -10°C under an argon atmosphere. 597 mg (3.32 mmol) of NBS were added and the mixture was stirred at -7°C for 1 h. It was warmed to RT and stirred for a further 4 h. 50 mL of water were added to the reaction mixture, which was extracted three times with MTBE. The combined organic phases were

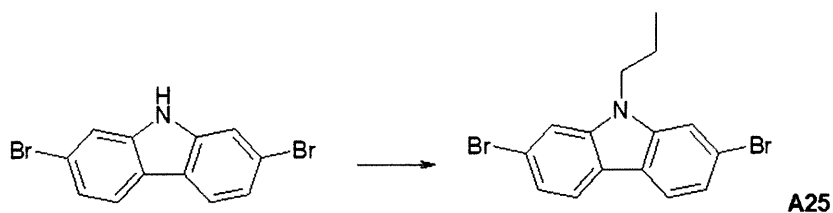
washed with 2M NaOH solution and sat. NaCl solution. They were dried over Na₂SO₄ and filtered, and the solvents were removed under reduced pressure. The residue was purified by chromatography using silica gel, and 375 mg of product **A23** (67%) were obtained as a pale yellow solid. ¹H NMR (acetone-d₆): 5.15-5.21 ppm (m, 1H), 4.57-4.61 (m, 2H).

5,7-Dibromo-2,3-dihydrothieno[3,4-b][1,4]dithiin (A24)



1.12 g (6.41 mmol) 2,3-dihydro-thieno[3,4-b][1,4]dithiin (Wijsboom, Angew. Chem. Int. Ed. 2009 (48), 30, 5443-5447) were dissolved in 16 mL of DMF at 0°C under an argon atmosphere. 2.36 g (13.1 mmol) of NBS were dissolved in 15 mL of DMF and added dropwise at 0°C. The mixture was warmed to RT and stirred for a further 4 h. 100 mL of 5% LiCl solution were added to the reaction mixture, which was extracted four times with MTBE. The combined organic phases were washed with 5% LiCl solution and sat. NaCl solution. They were dried over Na₂SO₄ and filtered, and the solvents were removed under reduced pressure. The residue was purified by chromatography using silica gel, and 1.80 g of product **A24** (85%) were obtained as a colorless oil. GC-MS (EI, 75eV) *m/z* 331.8 (M⁺, 100%).

2,7-Dibromo-9-propyl-9H-carbazole (A25)

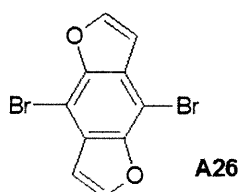


To a solution of potassium hydroxide (812 mg, 12.3 mmol) in dry dimethyl sulfoxide (25 mL) was added 2,7-dibromo-9H-carbazole (2.5 g, 7.69 mmol), and the mixture was stirred at room temperature for 15 min. Propyl bromide (1.43 g, 11.5 mmol) was added to the reaction mixture, which was stirred at room temperature for 16 h, then poured onto water (200 mL) and extracted with diethyl ether (3 x 100 mL). The combined organic phases were dried over sodium sulfate and

filtered, and the solvent was removed under reduced pressure.

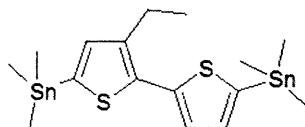
Purification by column chromatography (silica gel, petroleum ether) gave 2,7-dibromo-9-propyl-9H-carbazole (2.80 g, 7.63 mmol, 99%) as a colorless crystalline solid. ^1H NMR (CDCl_3): 7.89 ppm (2, 2H), 7.54 (d, 2H), 7.34 (dd, 2H), 4.17 (t, 2H), 1.89 (sext, 2H), 0.99 (t, 3H).

4,8-Dibromobenzo[1,2-b;4,5-b']difuran (A26)



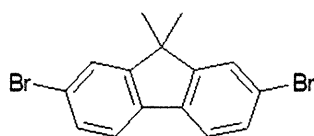
A26 was synthesized in accordance with the method known from literature (Bian, J. Material. Chem. A 2015, 3, 1920).

10 3-Ethyl-5,5'-bis(trimethylstannanyl)[2,2']bithiophenyl (A27)



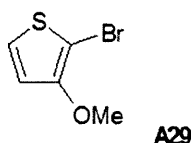
The compound was prepared in accordance with **A19**. ^1H NMR (CDCl_3): 7.14 (d, 1H), 7.06 (d, 1H), 6.95 (s, 1H), 2.74 (q, 2H), 1.19 (t, 3H), 0.37 (m, 18H).

15 2,7-Dibromo-9,9-dimethyl-9H-fluorene (A28)

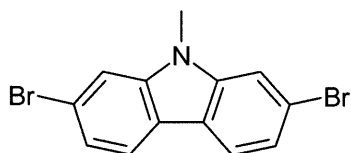


Compound **A28** is commercially available.

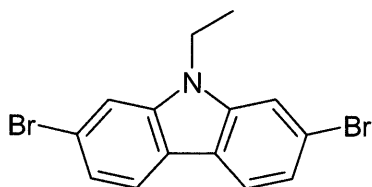
2-Bromo-3-methoxythiophene (A29)



20 The synthesis of **A29** was in accordance with the literature method of Canesi, Eleonora V. et al., Journal of the American Chemical Society, 134(46), 19070-19083; 2012

2,7-Dibromo-9-methyl-9H-carbazole (A30)

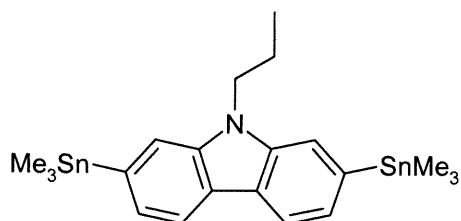
To an initially charged solution of potassium hydroxide (317 mg, 4.80 mmol) in dry dimethyl sulfoxide (12 mL) was added 2,7-dibromo-9H-carbazole (975 mg, 3.00 mmol), and the mixture was stirred at room temperature for 15 min. Subsequently, methyl iodide (426 mg, 0.456 mL, 3.00 mmol) was added dropwise and the mixture was stirred at room temperature for a further 16 h. The reaction mixture was poured onto water (100 mL) and extracted with diethyl ether (3 x 50 mL). The combined organic phases were dried over sodium sulfate and filtered off, and the solvent was removed under reduced pressure. Column chromatography (silica gel, petroleum ether) gave 2,7-dibromo-9-methyl-9H-carbazole (902 mg, 2.66 mmol, 89%) as a colorless crystalline solid. ^1H NMR (CDCl_3): 7.89 ppm (dd, 2H), 7.55 (d, 2H), 7.35 (dd, 2H), 3.79 (s, 3H).

2,7-Dibromo-9-ethyl-9H-carbazole (A31)

To an initially charged solution of potassium hydroxide (330 mg, 4.93 mmol) in dry dimethyl sulfoxide (11 mL) was added 2,7-dibromo-9H-carbazole (1.00 g, 3.08 mmol), and the mixture was stirred at room temperature for 15 min. Subsequently, ethyl bromide (503 mg, 0.345 mL, 4.62 mmol) was added dropwise and the mixture was stirred at room temperature for a further 16 h. The reaction mixture was poured onto water (80 mL) and extracted with diethyl ether (2 x 100 mL). The combined organic phases were dried over sodium sulfate and filtered off, and the solvent was removed under reduced pressure. Column chromatography (silica gel, petroleum ether) gave 2,7-dibromo-9-ethyl-9H-carbazole (890 mg, 2.52 mmol, 82%) as a colorless crystalline solid. ^1H NMR (CDCl_3): 7.90 ppm (d, 2H), 7.55 (d, 2H),

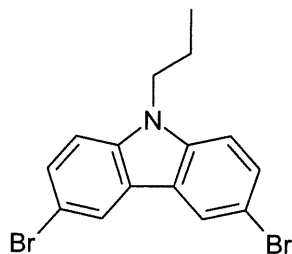
7.35 (dd, 2H), 4.28 (q, 2H), 1.43 (t, 3H). GC-MS (EI) m/z 352.81 (M^+ , 100%).

9-Propyl-2,7-bis(trimethylstannanyl)-9H-carbazole (A32)



5 To an initial charge of 2,7-dibromo-9-propyl-9H-carbazole (1.00 g, 2.72 mmol) under argon in dry tetrahydrofuran (50 mL) at -78°C was added dropwise, within 15 min, *tert*-butyllithium (1.5 M in pentane, 3.63 mL), and the mixture was stirred at -78°C for a further 1.5 h. Thereafter, trimethylstannyl chloride (1 M in tetrahydrofuran, 10 5.72 mL) was added to the reaction mixture, which was warmed to room temperature in the cooling bath while stirring overnight. Subsequently, the reaction mixture was poured onto water (200 mL) and extracted with diethyl ether (3 x 100 mL). The combined organic phases were washed with saturated NaCl solution (3 x 100 mL), dried 15 over sodium sulfate and filtered off, and the solvent was removed under reduced pressure. Recrystallization from methanol/ethanol (2:1) gave 9-propyl-2,7-bis(trimethylstannanyl)-9H-carbazole (780 mg, 1.46 mmol, 54%) as a colorless crystalline solid. ^1H NMR (acetone- D_6): 8.11 ppm (dd, 2H), 7.72-7.73 (m, 2H), 7.32 (dd, 2H), 4.44 (t, 2H), 20 1.87-1.97 (m, 2H), 0.94 (t, 3H), 0.35 (s, 18H).

3,6-Dibromo-9-propyl-9H-carbazole (A33)



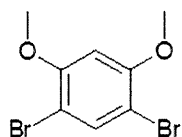
To an initially charged solution of potassium hydroxide (315 mg, 4.77 mmol) in dry dimethyl sulfoxide (11 mL) was added 3,6-dibromo-9H- 25 carbazole (1.00 g, 2.98 mmol), and the mixture was stirred at room temperature for 15 min. Subsequently, ethyl bromide (503 mg, 0.345

mL, 4.62 mmol) was added dropwise and the mixture was stirred at room temperature for a further 16 h. The reaction mixture was poured onto water (80 mL) and extracted with diethyl ether (2 x 100 mL). The combined organic phases were dried over sodium sulfate and filtered off, and the solvent was removed under reduced pressure. Column chromatography (silica gel, petroleum ether) gave 2,7-dibromo-9-ethyl-9H-carbazole (790 mg, 2.15 mmol, 72%) as a colorless crystalline solid. ^1H NMR (acetone- D_6): 8.37-8.39 ppm (m, 2H), 7.58-7.60 (m, 4H), 4.41 (t, 2H), 1.90 (m, 2H), 0.93 (t, 3H). GC-MS (EI) m/z 367.00 (M^+ , 83%).

2,7-Dibromo-9-isobutyl-9H-carbazole (A34)

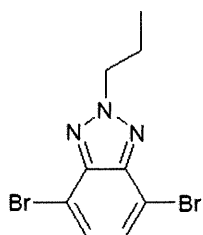
The synthesis of **A34** is analogous to the synthesis of **A31**.

1,5-Dibromo-2,4-dimethoxybenzene (A35)



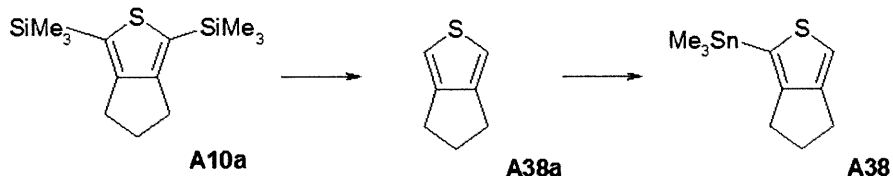
Compound **A35** is commercially available.

4,7-Dibromobenzo[1,2,5]triazole (A37)



Compound **A37** is commercially available.

5,6-Dihydro-4H-cyclopenta[c]thiophene (A38a)



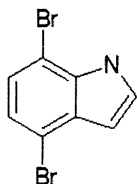
8.00 g (29.8 mmol) of 1,3-bis(trimethylsilyl)-5,6-dihydro-4H-cyclopenta[c]thiophene (**A10a**) were dissolved in 150 mL of THF under an argon atmosphere. 89.4 mL (89.4 mmol, 1.0 M in THF) of

tetrabutylammonium fluoride solution were added and the mixture was stirred for 3 h. 50 mL of sat. Na_2CO_3 solution were added to the reaction mixture, which was extracted three times with n-hexane. The combined organic phases were washed with sat. Na_2CO_3 solution, water and sat. NaCl solution. They were dried over Na_2SO_4 and filtered, and the solvents were removed under reduced pressure. The residue was purified by fractional distillation (7 mbar, 50°C - 55°C), and 2.89 g of 5,6-dihydro-4H-cyclopenta[c]thiophene product (78%) were obtained as a colorless oil. ^1H NMR (CDCl_3): 6.76 ppm (s, 2H), 2.67 (t, 4H), 2.37 (m, 2H).

2-Trimethylstannyl-5,6-dihydro-4H-cyclopenta[c]thiophene (A38)

2.66 g (21.4 mmol) of 5,6-dihydro-4H-cyclopenta[c]thiophene were dissolved in 75 mL of THF and cooled to -78°C . 9.0 mL (22.5 mmol) of 2.5 M n-butyllithium solution in hexane were added dropwise and stirred at -78°C for 2 h. 22.5 mL (22.5 mmol) of a 1.0 M trimethylstannyl chloride solution in THF were added and the mixture was warmed to room temperature overnight. Hydrolysis was effected with 15 mL of water, and the aqueous phase was extracted three times with n-hexane. The combined org. phases were washed with sat. NaCl solution and dried over Na_2SO_4 . After filtration, the solvents were distilled off under reduced pressure and the residue was used in the next stage without further purification. This gave 5.40 g of product **A38** (88%) as a yellow oil. ^1H NMR (CDCl_3): 7.04 ppm (m, 2H), 2.63-2.72 (m, 4H), 2.36-2.43 (m, 2H), 0.34 (s, 9H).

4,7-Dibromo-1H-indole (A39)



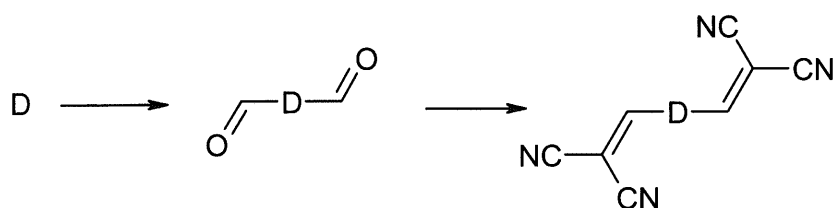
The synthesis of A39 is by the literature method: Dobbs, Adrian P.; Voyle, Martyn; Whittall, Neil, Synlett, 1999, 10, 1594-1596.

Synthesis of the reactants 2 (B)

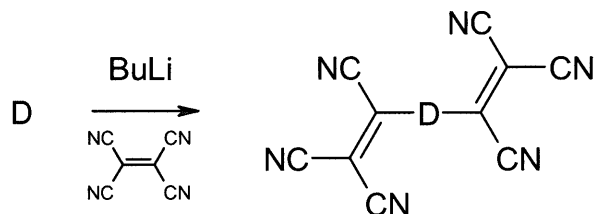
Terminal acceptor groups can be synthesized, for example, by known methods, for example Gattermann, Gattermann-Koch, Houben-Hoesch,

Vilsmeier/ Vilsmeier-Haack, Friedel-Crafts acylation or after lithiation, by a reaction with an acid derivative or carbonylating reagent.

Further acceptor groups are achievable by trans-functionalization of the above-described carbonyl function C(O)R, for example by Knoevenagel condensation, as shown for reactant **B4**.



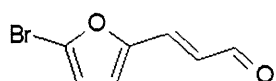
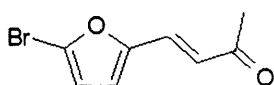
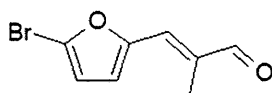
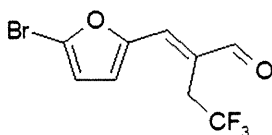
Acceptor end groups can be introduced, for example, with BuLi and tetracyanoethylene (Cai et al, J. Phys. Chem. B 2006, 110, 14590).



10

Alternatively, the reaction can also be conducted without BuLi in DMF (Pappenfus et. al, Org. Lett. 2008, 10, 8, 1553).

B1, B5, B9, B11

**B1****B5****B9****B11**

The synthesis of **B1**, **B5**, **B9** and **B11** is in accordance with the literature of I. I. Popov, Z. N. Nazarova, A. P. Chumak, Chem. Heterocycl. Compd., 1978, 14, (3), 253-255.

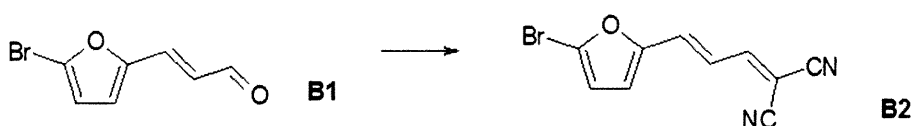
50 mmol of 5-bromo-2-furfural (reactant 1) were suspended in 100 mL of 6% NaOH solution. Carbonyl compound (reactant 2) in 15 mL of water

was added dropwise to the reaction mixture at 0°C. Stirring was continued at 0°C for 1 h. The precipitate was filtered off, washed with water and dried. The crude product was purified by chromatography using silica gel.

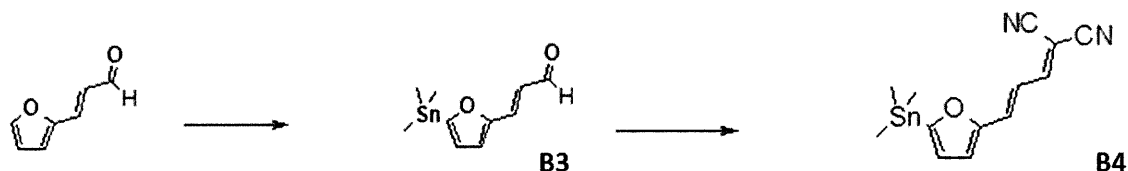
Name	Reactant 2	Yield, %	¹ H NMR
B1	acetaldehyde	74	acetone-d ₆ : 9.64 ppm (d, 1H), 7.44 (d, 1H), 7.04 (d, 1H), 6.73 (d, 1H), 6.47 (dd, 1H).
B5	acetone	55	CDCl ₃ : 7.17 ppm (d, 1H), 6.63 (d, 1H), 6.61 (d, 1H), 6.43 (d, 1H), 2.32 (s, 3H).
B9	propionaldehyde	98	acetone-d ₆ : 9.52 ppm (s, 1H), 7.18 (s, 1H), 7.00 (s, 1H), 6.75 (s, 1H), 2.03 (d, 3H).
B11	4,4,4-trifluorobutanal	46	acetone-d ₆ : 9.60 ppm (s, 1H), 7.53 (s, 1H), 7.19 (s, 1H), 6.82 (s, 1H), 3.65 (q, 2H).

5 **Table 4:** Synthesis

(E)-3-(5-Bromofuran-2-yl)allylidene]malononitrile (B2)



36.7 mmol of (E)-3-(5-bromofuran-2-yl)propenal and 44.0 mmol of malonitrile were dissolved in 50 mL of ethanol. 3.7 mmol of β-alanine
 10 were added thereto and the reaction mixture was stirred at room temperature for 24 h. The precipitated solids were briefly heated to boiling and then cooled in an ice bath. The crystallized solids were filtered off and washed with a little ethanol. After drying in a desiccator, 3.49 g of [(E)-3-(5-bromofuran-2-yl)allylidene]-
 15 malononitrile **B2** (38% yield) were isolated. EI m/z: 250[M], 169, 141, 114.

(E)-3-(5-Trimethylstannylfuran-2-yl)propenal (B3)

To a solution of 3.06 g (29.9 mmol) of 1-methylpiperazine in 82 mL of anhydrous THF were added dropwise, under an argon atmosphere
 5 at -78°C , 12 mL (30 mmol) of *n*-butyllithium solution (2.5M in hexane). After stirring for 15 min, 3.15 g (25.0 mmol) of *trans*-3-(2-furyl)-acrolein were added dropwise. After stirring for a further 15 min, 3.95 g (33.7 mmol) of *N,N,N',N'*-tetramethylethylenediamine were added dropwise. After stirring for 15 min, 13.4 mL (33.5 mmol) of *n*-
 10 butyllithium solution (2.5M in hexane) were added dropwise. The reaction mixture was stirred at -20°C for 3 h and then cooled down again to -78°C . At this temperature, 29.9 mL (29.9 mmol) of a 1M solution of trimethyltin chloride in THF were added and the mixture was then stirred at R.T. for 16 h. Subsequently, 100 mL of water were
 15 added, the organic phase was removed, the aqueous phase was extracted three times with MTBE and the combined organic phases were washed with 80 mL each of a 1M hydrochloric acid, saturated ammonium chloride solution and brine. After drying over sodium sulfate, the solvents were distilled off and the residue was purified by
 20 chromatography (SiO_2 , petroleum ether/MTBE 5/1). Yield 5.52 g (76%). ^1H NMR (400 MHz) in acetone- d_6 : 0.38 (s, 9H), 6.48 (dd, 1H), 6.84 (d, 1H), 6.97 (d, 1H), 7.51 (d, 1H), 9.63 (d, 1H).

2-[(E)-3-(5-Trimethylstannanylfuran-2-yl)allylidene]malononitrile (B4)

25 Under an argon atmosphere, 9.52 g (33.4 mmol) of **B3** and 2.23 g (33.4 mmol) of malonitrile were dissolved in 19 mL of ethanol. 152 mg (1.67 mmol) of beta-alanine were added and the mixture was stirred at R.T. for 4 h. Subsequently, the mixture was heated to reflux temperature and gradually cooled down to 0°C while stirring. The
 30 precipitate was filtered off, washed with 2 mL of ethanol and dried under reduced pressure: 9.10 g (82%) of orange crystalline solids.

^1H NMR (400 MHz) in acetone- d_6 : 0.41 (s, 9H), 6.90 (d, 1H), 7.07 (m, 2H), 7.46 (d, 1H), 8.01 (d, 1H)

2-[(E)-3-(5-Bromofuran-2-yl)-1-methylallylidene]malononitrile (B6)



5 1.61 g (7.47 mmol) of (E)-4-(5-bromofuran-2-yl)but-3-en-2-one (**B5**) and 2.47 g (37.4 mmol) of malononitrile were dissolved in 60 mL of 1,2-dichloroethane under an argon atmosphere. 4.29 g (14.9 mmol) of titanium(IV) isopropoxide were added and the reaction mixture was heated to 110°C for 20 h. The mixture was allowed to cool to RT, and
10 100 mL of 1N HCl solution were added. The mixture was stirred at RT for 1 h, then the phases were separated and the aqueous phase was extracted with DCM. The combined organic phases were washed with 1N HCl solution and sat. NaHCO_3 solution, dried over Na_2SO_4 and filtered. The solvents were distilled off under reduced pressure and the
15 residue chromatographically using silica gel (R_f (PE:DCM (1:2)) = 0.30). This gave 1.08 g of product **B6** (55%) as an orange solid.
 ^1H NMR (acetone- d_6): 7.46 ppm (d, 1H), 7.17 (d, 1H), 7.03 (d, 1H), 6.76 (d, 1H), 2.48 (s, 3H).

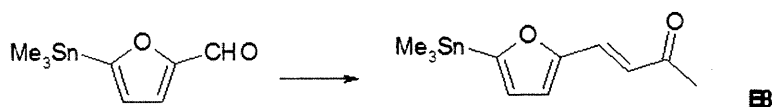
5-Trimethylstannylfuran-2-carbaldehyde (B7)



20 To a solution of 6.13 g (60.0 mmol) of 1-methylpiperazine in 160 mL of anhydrous THF under an argon atmosphere at -78°C were added dropwise 22.4 mL (56.0 mmol) of n-butyllithium solution (2.5 M in hexane). After stirring for 15 min, 4.85 g (50.0 mmol) of 2-
25 furaldehyde were added dropwise. After stirring for a further 15 min, 7.92 g (67.5 mmol) of N,N,N',N'-tetramethylethylenediamine were added dropwise. After stirring for 15 min, 24.0 mL (60.0 mmol) of n-butyllithium solution (2.5 M in hexane) were added dropwise. The reaction mixture was stirred at -20°C for 3 h and then cooled down
30 again to -78°C. At this temperature, 60.0 mL (60.0 mmol) of a 1.0 M solution of trimethyltin chloride in THF were added and the mixture

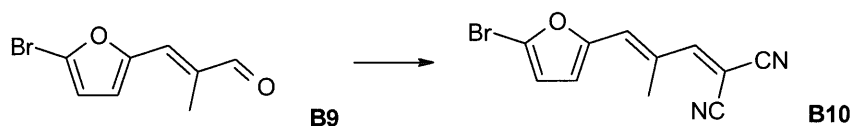
was then stirred at RT for 16 h. Subsequently, 100 mL of water were added, the organic phase was removed, the aqueous phase was extracted three times with MTBE and the combined organic phases were washed with 80 mL each of a 1 M hydrochloric acid and sat. sodium chloride solution. After drying over sodium sulfate, the solvents were distilled off and the residue was purified by chromatography (SiO₂, PE/MTBE 4/1). Yield 8.69 g (67%) as a yellow oil. ¹H NMR (400 MHz) in acetone-d₆: 9.67 ppm (s, 1H), 7.39 (d, 1H), 6.90 (d, 1H), 0.40 (s, 9H).

10 (E)-4-(5-Trimethylstannylfuran-2-yl)-but-3-en-2-one (B8)



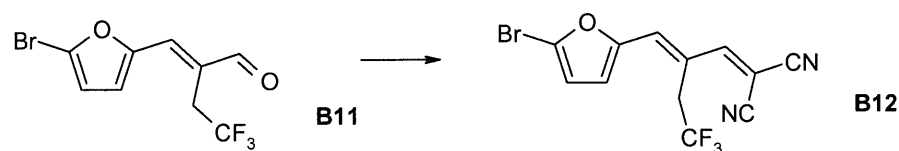
To a solution of 8.69 g (33.5 mmol) of 5-trimethylstannylfuran-2-carbaldehyde (**B7**) in 67 mL of THF were added, under an argon atmosphere, 11.3 g (35.2 mmol) of 1-(triphenylphosphoranylidene)-2-propanone. The reaction mixture was heated to 50°C for 96 h. The solvent was distilled off and the residue was purified by chromatography (SiO₂, PE/EA 3/1). Yield 9.14 g (91%) as a yellow oil. ¹H NMR (400 MHz) in acetone-d₆: 7.42 ppm (d, 1H), 6.85 (d, 1H), 6.80 (d, 1H), 6.54 (d, 1H), 2.28 (s, 3H), 0.34 (s, 9H).

20 2-[(E)-3-(5-Bromofuran-2-yl)-2-methylallylidene]malononitrile (B10)



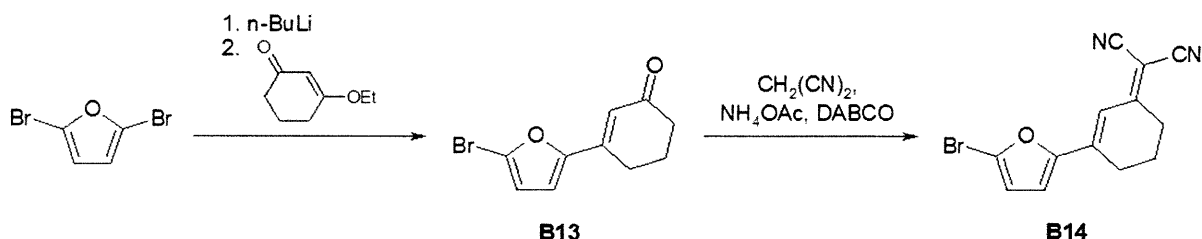
B10 (as B2): yield 81%, ¹H NMR in d₆-acetone, ppm: 7.82 (s, 1H), 7.13 (s, 1H), 7.09 (d, 1H), 6.81 (d, 1H), 2.48 (s, 3H).

25 2-{2-[1-(5-Bromofuran-2-yl)meth-(E)-ylidene]-4,4,4-trifluorobutylidene}malononitrile (B12)



The synthesis of **B12** is effected in an analogous manner to **B2**. Yield 58%, ^1H NMR in d_6 -acetone, ppm: 7.93 (s, 1H), 7.47 (s, 1H), 7.24 (d, 1H), 6.87 (d, 1H), 4.10 (qa, 2H).

5 3-(5-Bromofuran-2-yl)cyclohex-2-enone (B13)



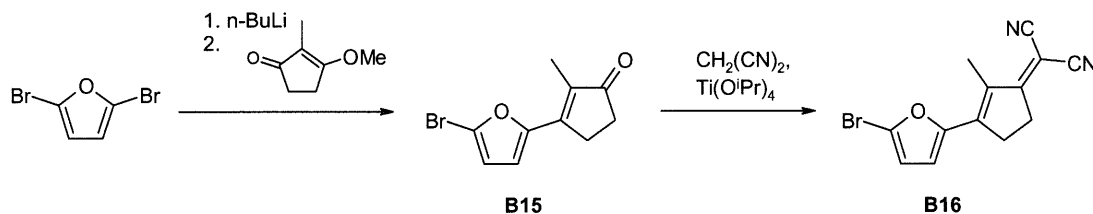
To a solution of 2.00 g of 2,5-dibromofuran (8.85 mmol) in 25 mL of diethyl ether at -65°C under an argon atmosphere were added dropwise, while stirring, 5.53 mL of *n*-butyllithium (1.6M in hexane) within 15 min. After a further 15 min, 1.86 g of 3-ethoxy-2-cyclohexen-1-one (13.3 mmol) were added and the mixture was warmed to R.T. overnight. The mixture was added to 150 mL of brine and extracted with 3 x 100 mL of dichloromethane. The combined organic extracts were washed with 2M hydrochloric acid and dried over sodium sulfate, and the solvents
15 were removed under reduced pressure. After purification by column chromatography (SiO_2 , dichloromethane), **B13** was obtained as a yellow crystalline solid (1.08 g, 4.48 mmol, 51%). ^1H NMR (CDCl_3): 6.68 ppm (d, 1H), 6.44-6.43 (m, 2H), 2.60 (td, 2H), 2.46 (t, 2H), 2.14-2.07 (m, 2H).

20 2-[3-(5-Bromofuran-2-yl)cyclohex-2-enylidene]malononitrile (B14)

Under an argon atmosphere, 1.68 g of ammonium acetate (21.8 mmol) were added to a solution of 1.74 g **B13** (7.14 mmol) and 1.42 g of malononitrile (21.5 mmol) in dichloroethane. The mixture was refluxed for 2 h, then 20 mg of 1,4-diazabicyclo[2.2.2]octane (0.178 mmol)
25 were added and then the mixture was refluxed for a further 16 h. The reaction mixture was added to 100 mL of water and extracted with 3 x 50 mL of dichloromethane. The combined organic extracts were washed with 100 mL of water and dried over sodium sulfate, and the solvents were removed under reduced pressure. After purification by column
30 chromatography (SiO_2 , hexane), **B14** was obtained as an orange

crystalline solid (1.15 g, 3.98 mmol, 91%). ^1H NMR (CDCl_3): 7.19 ppm (s, 1H), 6.79 (d, 1H), 6.49 (d, 1H), 2.80 (t, 2H), 2.64–2.61 (m, 2H), 2.00–1.94 (m, 2H).

3-(5-Bromofuran-2-yl)-2-methylcyclopent-2-enone (B15)



5

To a solution of 3.46 g of 2,5-dibromofuran (15 mmol) in 45 mL of diethyl ether at -65°C under an argon atmosphere were added dropwise, while stirring, 6.00 mL of n-butyllithium (2.5M in hexane, 15 mmol) within 30 min. After a further 15 min, 2.94 g of 3-ethoxy-2-methyl-2-cyclopenten-1-one (21.0 mmol) dissolved in 15 mL of diethyl ether were added and the mixture was stirred at -65°C for 1.5 h and then warmed to R.T. overnight. After the addition of 150 mL of dichloromethane, the mixture was added to 300 mL of 1M hydrochloric acid. The organic phase was removed and the aqueous phase was extracted once with 100 mL of dichloromethane. The combined organic phases were washed with 2M hydrochloric acid (150 mL) and water (100 mL) and dried over sodium sulfate, and the solvents were removed under reduced pressure. After purification by column chromatography, (SiO_2 , dichloromethane/hexane), **B15** was obtained as a yellow crystalline solid (2.10 g, 8.71 mmol, 58%). ^1H NMR (CDCl_3): 6.75 ppm (d, 1H), 6.50 (d, 1H), 2.86–2.82 (m, 2H), 2.52–2.49 (m, 2H), 2.02 (t, 3H).

20

2-[3-(5-Bromofuran-2-yl)-2-methylcyclopent-2-enylidene]malononitrile (B16)

To a solution of 1.30 g of 3-(5-bromofuran-2-yl)-2-methylcyclopent-2-enone (**B15**) (5.39 mmol) and 3.60 g of malononitrile (53.9 mmol) in 1,2-dichloroethane were added, under an argon atmosphere, 3.09 g of tetraisopropyl orthotitanate (10.8 mmol) and the mixture was stirred under reflux for 3 d. The reaction mixture was poured onto hydrochloric acid (1M, 200 mL), stirred vigorously for 30 min and extracted with dichloromethane (3 x 100 mL). The combined organic

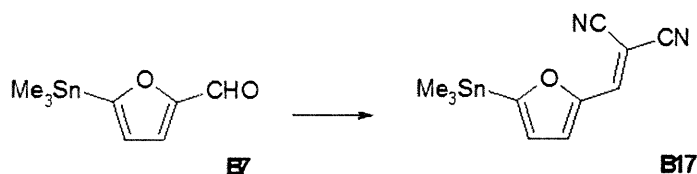
30

phases were washed with water (100 mL), dried over sodium sulfate and filtered, and the solvent was removed under reduced pressure.

Purification by column chromatography (silica gel, dichloromethane) gave **B16** (1.37 mg, 4.75 mmol, 88%) as an orange crystalline solid.

5 ^1H NMR (CDCl_3): 6.82 ppm (d, 1H), 6.55 (d, 1H), 3.09–3.06 (m, 2H), 3.00–2.96 (m, 2H), 2.40 (t, 3H).

2-(5-Trimethylstannylfuran-2-ylmethylene)malononitrile (B17)

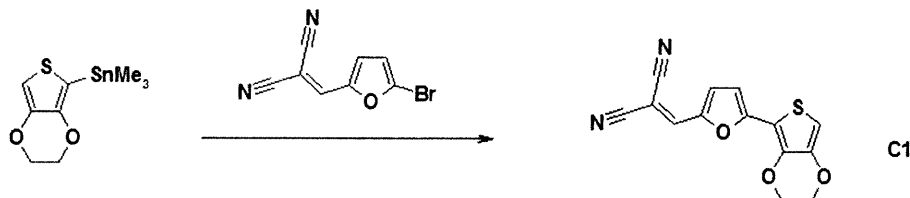


The synthesis of **B17** proceeding from **B7** is analogous to **B4**

10 Synthesis of reactant C2

The reactants needed for the simple Stille coupling can, as already described, be prepared from the electron-rich stannyl compound and the electron-deficient bromide. Analogously, there are various different options known from the literature for this purpose. The preparation of reactant **C1** was accomplished here using Stille coupling reactions. With N-iodosuccinimide, it was possible to convert **C1** as starting point for a new Stille coupling reaction to **C2**.

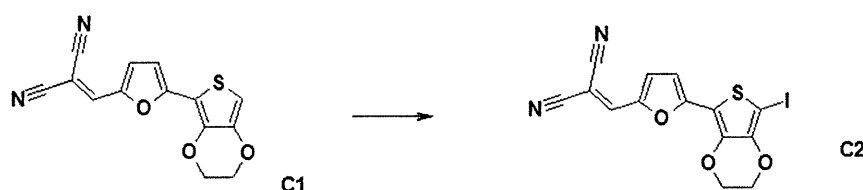
20 2-[5-(2,3-Dihydrothieno[3,4-b][1,4]dioxin-5-yl)furan-2-ylmethylene]-malononitrile (C1)



1.49 g (4 mmol) of (2,3-dihydrothieno[3,4-b][1,4]dioxin-5-yl)-trimethylstannane and 0.89 g (4 mmol) of **C4** were dissolved in 20 mL of dry toluene and the reaction mixture was degassed. Subsequently, 140 mg (0.12 mmol) of tetrakis(triphenylphosphine)palladium(0) were added and the reaction mixture was heated to boiling overnight. The reaction mixture was brought to room temperature, and 300 mL of

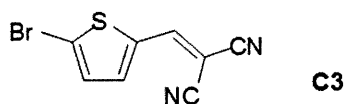
dichloromethane were added. The organic phase was removed, washed three times with sat. NaCl solution and dried over sodium sulfate. The solvent was removed on a rotary evaporator. The residue was chromatographed using silica gel in petroleum ether/DCM = 1/3 (Rf 0.1). This gives 982 mg of **C1**. ¹H NMR (CDCl₃) ppm: 7.18 (s, 2H), 6.81 (d, 1H), 6.47 (d, 1H), 4.30 (m, 2H), 4.21 (m, 2H).

2-[5-(7-Iodo-2,3-dihydrothieno[3,4-b][1,4]dioxin-5-yl)furan-2-ylmethylene]malononitrile (C2)

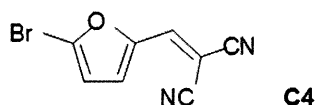


301 mg (1.06 mmol) of **C1** were dissolved in 6 mL of dry DMF and cooled down to 0°C under argon. 241 mg (1.06 mmol) of N-iodosuccinimide were added in portions and then stirred at room temperature overnight. Ice-water was added to the reaction mixture, which was brought to room temperature while stirring. The aqueous mixture was extracted three times with 50 mL of dichloromethane. The organic phase was washed twice with 50 mL of sat. NaCl solution and once with 50 mL of 5% LiCl solution, and dried over sodium sulfate. The solvent was removed by rotary evaporator, and the residue was chromatographed using silica gel with dichloromethane (Rf 0.58). This gives 413 mg of **C2**. ¹H NMR (CDCl₃) ppm: 7.35 (s, 1H), 6.55 (d, 2H), 4.32 (m, 4H).

2-(5-Bromothiophen-2-ylmethylene)malononitrile (C3)

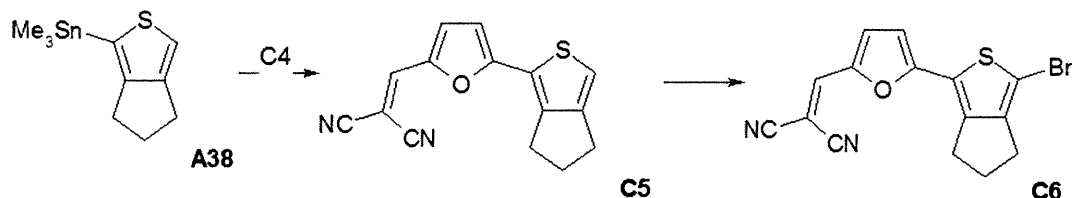


2-(5-Bromofuran-2-ylmethylene)malononitrile (C4)



Compounds **C3** and **C4** are prepared in accordance with the synthesis described in the literature (Qi et al., J. Mat. Chem. 2008, 18, 1131).

2-[5-(5,6-Dihydro-4H-cyclopenta[c]thiophen-1-yl)furan-2-ylmethylene]-malononitrile (C5)

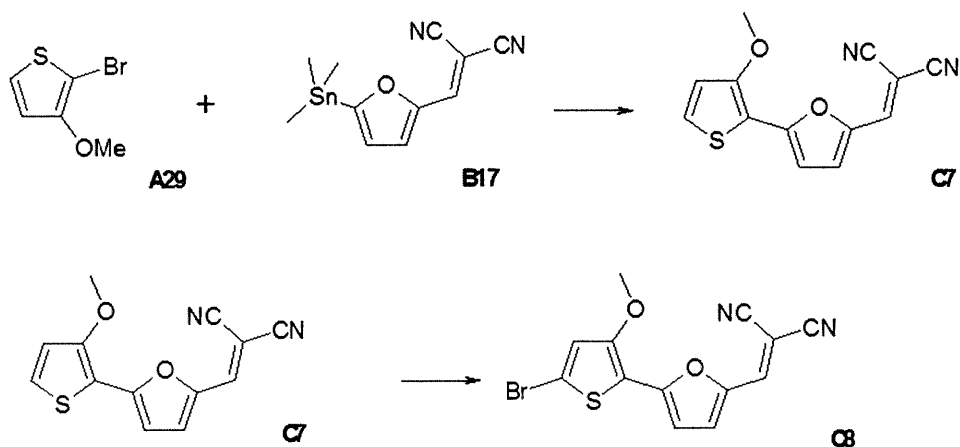


2.10 g (7.32 mmol) of 2-trimethylstannyl-5,6-dihydro-4H-
 5 cyclopenta[c]thiophene (**A38**) and 1.63 g (7.32 mmol) of 2-[(5-
 bromofuran-2-yl)methylene]malononitrile (**C4**) were dissolved in 28 mL
 of 1,4-dioxane. 37 mg (73 μ mol) of bis(tri-tert-butylphosphine)-
 palladium(0) were added and the mixture was heated to 80°C for 16 h.
 After it had been cooled down to room temperature, water was added to
 10 the reaction mixture and it was extracted three times with ethyl
 acetate. The combined organic phases were washed with water and sat.
 NaCl solution. They were dried over Na₂SO₄ and filtered, and the
 solvents were removed under reduced pressure. The residue was
 purified by chromatography (SiO₂, R_f (Hex:DCM (1:1)) = 0.19), and
 15 1.50 g of product **C5** (68%) were obtained red solid. ¹H NMR (acetone-
 D₆): 7.91 ppm (s, 1H), 7.54 (d, 1H), 7.19 (1s, 1H), 6.91 (d, 1H),
 2.97 (t, 2H), 2.72 (t, 2H), 2.44-2.51 (m, 2H).

2-[5-(3-Bromo-5,6-dihydro-4H-cyclopenta[c]thiophen-1-yl)furan-2-ylmethylene]malononitrile (C6)

20 266 mg (1.00 mmol) of 2-[5-(5,6-dihydro-4H-cyclopenta[c]thiophen-1-
 yl)furan-2-ylmethylene]malononitrile (**C5**) were dissolved in 10 mL of
 THF at 0°C under an argon atmosphere. 178 mg (1.00 mmol) of NBS were
 added in portions and the mixture was stirred at 0°C for 15 min. The
 mixture was warmed to RT and stirred for a further 16 h. The reaction
 25 mixture was cooled to 0°C and the precipitate was filtered off. The
 precipitate was dried under reduced pressure and 244 mg of product **C6**
 (71%) were obtained as a red solid. ¹H NMR (acetone-D₆): 7.97 ppm (s,
 1H), 7.54 (d, 1H), 6.91 (d, 1H), 3.05 (t, 2H), 2.65 (t, 2H), 2.47-
 2.55 (m, 2H).

Synthesis of **C7** and **C8**

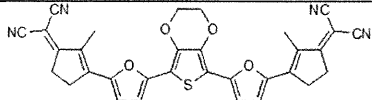
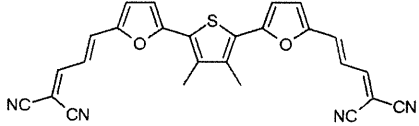
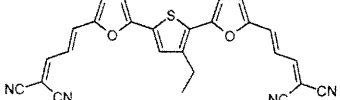
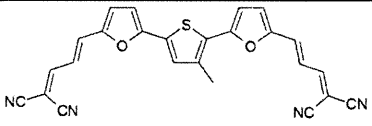
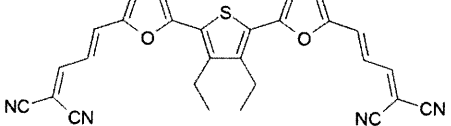
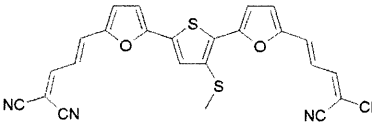
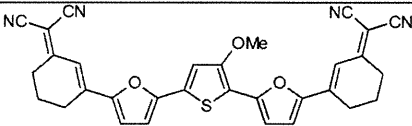
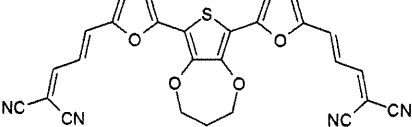
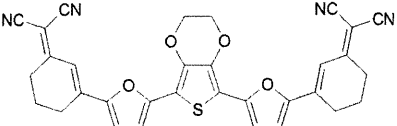
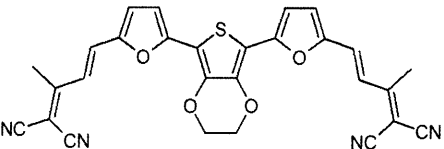
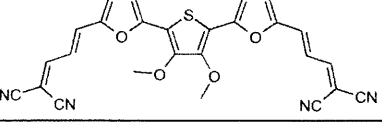


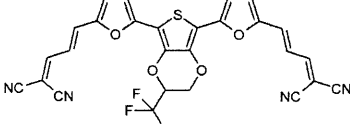
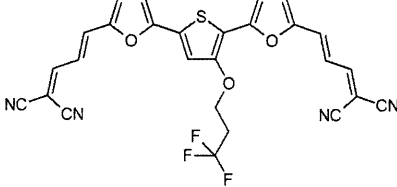
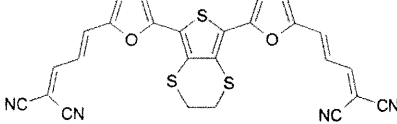
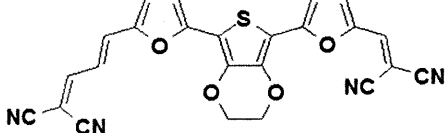
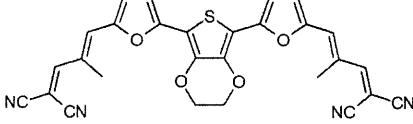
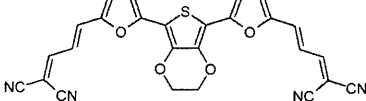
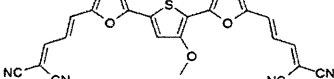
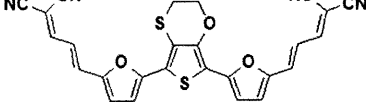
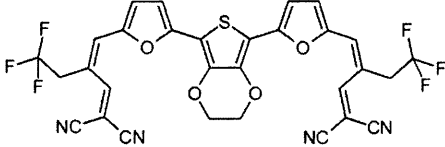
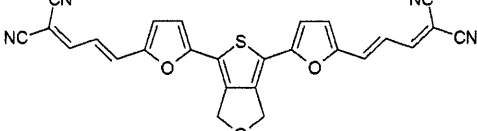
The synthesis of **C7** and **C8** was in analogy to **C5** and **C6**.

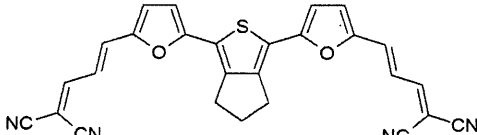
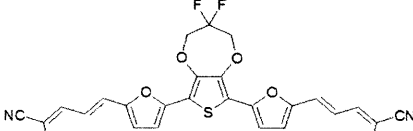
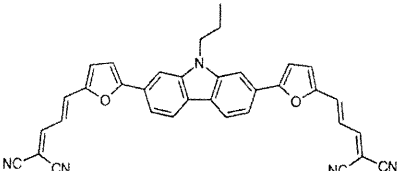
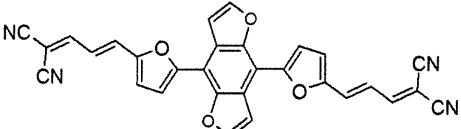
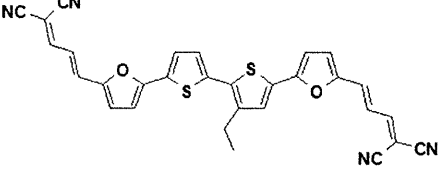
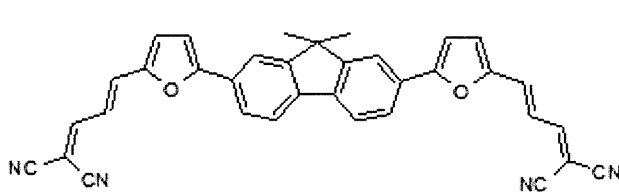
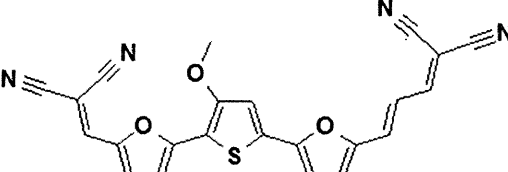
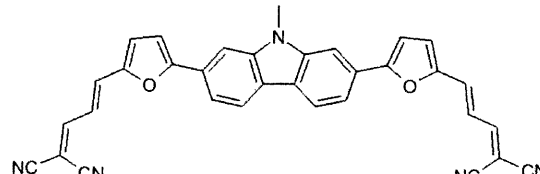
5 Properties of the compound of the invention

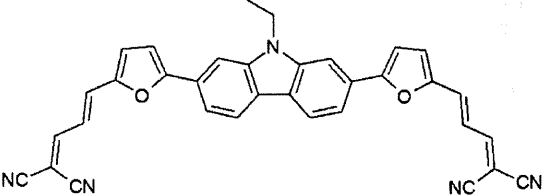
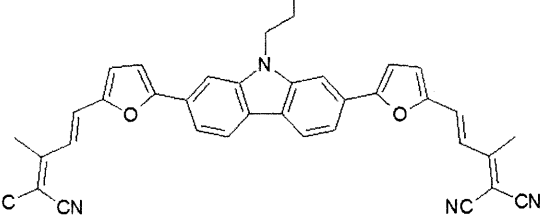
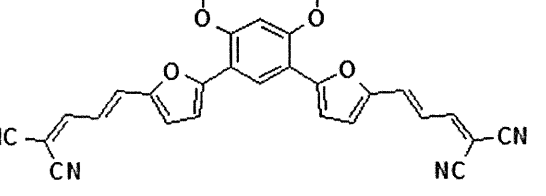
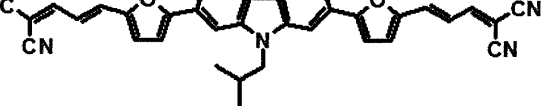
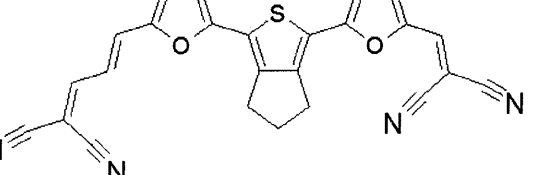
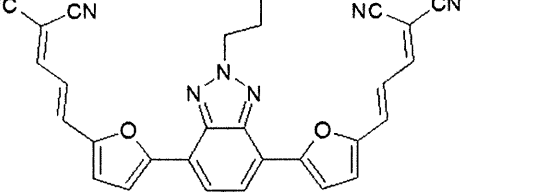
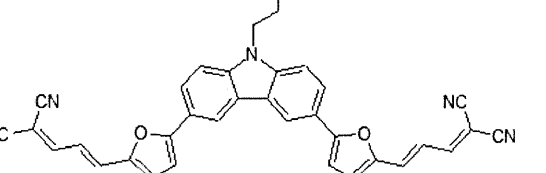
Some specific working examples of the compound of the invention and the optical properties thereof are given hereinafter:

No.	Structure	λ_{max} (solv.)/ nm ^b	FWHM film*/eV ^c
1		435	2.20
2		444	1.17
3		534	0.83
4		540	1.09
5		542	1.14
6		542	1.30

No.	Structure	λ_{max} (solv.) / nm ^b	FWHM film* / eV ^c
7		542	1.42
8		548	1.18
9		551	1.13
10		552	1.19
11		554	0.99
12		555	2.38
13		556	1.24
14		562 (THF)	2.41
15		563	1.27
16		567	2.32
17		568	1.91

No.	Structure	λ_{max} (solv.)/ nm ^b	FWHM film*/eV ^c
18		571	1.38
19		574	1.22
20		575	1.10
21		577	1.38
22		578	2.36
23		588	1.42
24		591	1.31
25		596	1.13
26		597	1.23
27		547	1.11

No.	Structure	λ_{max} (solv.)/ nm ^b	FWHM film*/eV ^c
28		572	1.10
29		550	2.22
30		523	1.01
31		574	0.82
32		540	1.08
33		513	1.05
34		548	1.26
35		527	0.99

No.	Structure	λ_{max} (solv.)/ nm ^b	FWHM film*/eV ^c
36		519	0.97
37		500	1.84
38		447	1.16
39		526	0.98
40		542	0.97
41		526	1.30
42		511	0.89

No.	Structure	λ_{max} (solv.)/ nm ^b	FWHM film [*] /eV ^c
43		510	0.89
44		517	1.97
45		518	0.77
46		511	1.04
47		554	1.08
48		455	87

Table 5: Overview of working examples and optical properties^a DSC onset ^b in dichloromethane unless stated otherwise^c 30 nm in film applied by vapor deposition under reduced pressure

DSC stands for differential scanning calorimetry (dynamic differential calorimetry).

The optical properties were determined experimentally in each case.

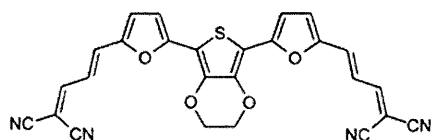
5 The absorption maximum $\lambda_{\max}$ in nm was ascertained with a dilute solution in a cuvette (in dichloromethane unless stated otherwise) with the aid of a photometer. The absorption maxima measured for all the compounds described are between 400 and 600 nm and thus overlap particularly advantageously with the energy maximum of the solar
10 spectrum.

Further optical properties such as the full width at half maximum (FWHM) were determined directly on films of the organic compounds. For this purpose, by means of vacuum sublimation at 10^{-6} to 10^{-7} mbar, a film of thickness 30 nm of the respective compound of the invention
15 was produced. The layer thickness was determined by means of a crystal oscillator monitor.

The compounds of the invention feature particularly high absorption in a broad spectrum of visible light, which is reflected in the high values achieved for the full width at half maximum. The compounds of
20 the invention thus enable absorption of photons over a comparatively broad spectral range comprising a high proportion of short-wave visible sunlight and conversion thereof to electrical energy.

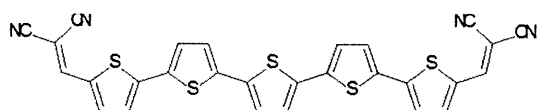
The invention is to be elucidated further hereinafter with reference
25 to a series of figures:

Figure 1 compares normalized absorption spectra in electron-volts (measured on: 30 nm film, vapor-deposited under reduced pressure, as described above). What is shown is a comparison of compound **23** with two comparative materials.

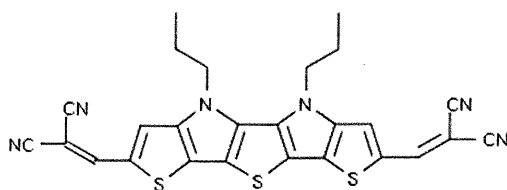


30

Compound **23**

Comparative material **1**

(Fitzner et al., Adv. Funct. Mat. 2011, 21, 897-910)

Comparative material **2**

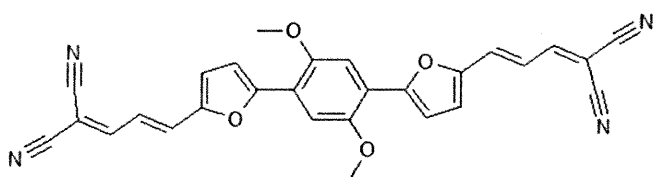
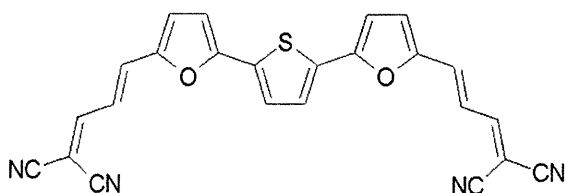
(Mishra et al., Adv. Mat. 2014, 26, 7217-7223).

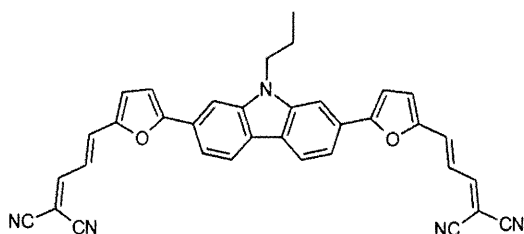
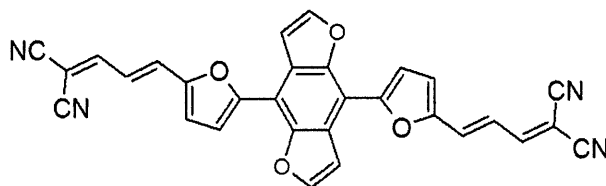
5 The measurement compares the absorption plotted against the energy of the incident light in electron-volts. A particularly high full width at half maximum can be observed in the short-wave spectral region. Especially in the region of 2.5 eV and higher energies, i.e. for 500 nm or shorter wavelengths, compound **23** shows much higher

10 absorption than the comparative materials. In general, the compounds of the invention, particularly in the range between 400 and 600 nm, show much better absorption properties. This makes it possible to generate photocurrents which utilize short-wave photons in a high proportion. These photons, by contrast, are frequently utilized only

15 inadequately by conventional organic compounds.

Figure 2 shows absorption spectra of inventive compounds **3**, **5**, **30**, **31**:

Compound **3**Compound **5**

Compound **30**Compound **31**.

The absorption spectra were again obtained on films of the compounds having a thickness of 30 nm, which were produced and analyzed as specified above. The figure thus compares compounds of the invention which differ in the choice of structural units for the middle conjugated D¹-D³ block. The spectrum shows the absorption plotted against the wavelength in nanometers. Astonishingly, all the specified compounds **3**, **5**, **30** and **31**, in spite of the different kinds of middle conjugated blocks, show a very broad absorption spectrum with good absorption even in the region of short wavelengths. At the same time, through the utilization of different middle conjugated blocks, it is possible to achieve fine adjustments in the absorption spectrum.

Figure 3 shows the absorption spectrum of compound **4** (measured on 30 nm film of compound **4**; PL: photoluminescence).

Figure 4 shows the current-voltage curves (j-V) that have been obtained using a photoactive organic electronic component in the form of an organic solar cell comprising compound **4**. The measurement was conducted without a mask.

Measurements on photoactive organic electronic components were each conducted here and hereinafter (see figures 6 and 8) with what is called a BHJ cell. Each cell has a glass substrate to which a transparent top contact of ITO has been applied (ITO = indium tin oxide). The cell additionally in each case has a layer comprising buckminsterfullerene (C₆₀) and a mixed layer of the respective

compounds of the invention with C60, and also a p-doped hole transport layer. The reverse contact consists of a gold layer applied by vapor deposition.

Figure 4 shows the current-voltage curve of compound **4** in a BHJ cell as just shown above. In the specific case, the BHJ cell has, atop the ITO layer, a layer of C60 having a thickness of about 15 nm. Compound **4** has been applied to this layer together with C60 with a thickness of 30 nm. This layer is in turn followed by a layer of BPAPF having a thickness of about 10 nm. Atop said layer there is a further layer comprising BPAPF and NDP9 (commercially available p-dopant, Novaled AG) having a thickness of 30 nm. The proportion of BPAPF in this layer, based on the overall layer, is 90 percent by weight. This layer is followed by a further layer comprising NDP9 with a thickness of 1 nm, which is then followed by a gold layer with a thickness of 50 nm.

The graph shows two current-voltage curves which differ in the thickness of the mixed layer of compound **4** and C60 (20 and 30 nm). The current-voltage curve also contains the most important indices that characterize the organic solar cell of the invention. The most important indices here are the fill factor FF (quotient of maximum power of a solar cell at the point of maximum performance and the product of open-circuit voltage and short-circuit current, the open-circuit voltage U_{oc} and the short-circuit current j_{sc}).

The current-voltage curves and the indices obtained demonstrate, using the example of compound **4**, that the compounds of the invention are suitable for use in organic solar cells.

Figure 5 shows the absorption spectrum of compound **5** (measured on 30 nm film of compound **5**).

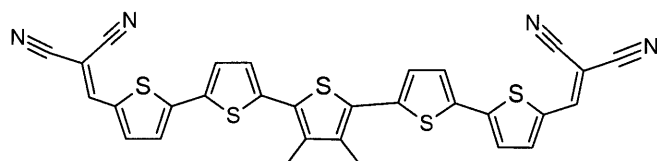
Figure 6 shows two current-voltage curves of compound **5** (layer thickness of the mixed layer with C60 20 and 30 nm, made up in a mixing ratio of 3:2 and at a substrate temperature of 50°C), measured in a BHJ cell as already described in general terms above (in connection with figure 3). The specific layer sequence is as follows: ITO/C60 (15 nm)/compound **5**:C60 (20/30 nm, 3:2)/BPAPF (10 nm)/BPAPF:NDP9 (30 nm, 10wt%)/NDP (1nm) Au (50 nm)

Figure 7 shows the absorption spectrum of compound **24** (measured on 30 nm film of compound **24**).

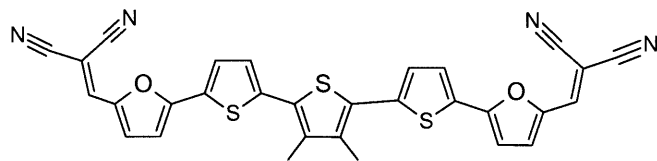
Figure 8: the current-voltage curves of compound **24** measured in a BHJ cell as already described in general terms above (in connection with figure 3), layer thickness of the mixed layer of compound **24** with C60 respectively 20 and 30 nm, made up in a mixing ratio of 1:1 at substrate temperature 70°C. The specific layer sequence is as follows: ITO/C60 (15 nm)/compound **24** (20/30 nm, 1:1)/BPAPF (5 nm)/BPAPF:NDP9 (45 nm, 10.1 wt%)/NDP9(1 nm) Au (50 nm).

Both the absorption properties of the compounds examined in figures 1, 2, 3, 5 and 7 and the current-voltage profiles measured in the organic solar cells in figures 4, 6 and 8 demonstrate that the compounds of the invention are suitable for use in organic solar cells and other photoactive organic electronic components and enable good efficiency.

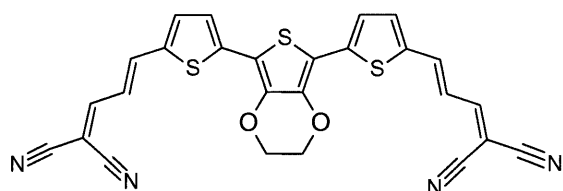
Table 6 additionally summarizes some optical properties of compounds of the invention and further comparative materials. These comparative materials are comparative materials **3** to **6**:



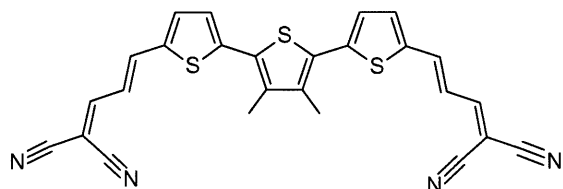
Comparative material **3**



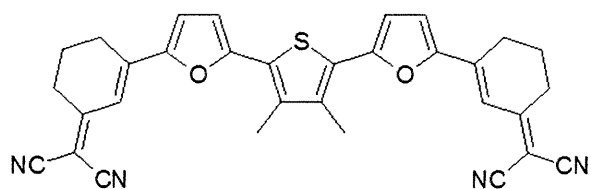
Comparative material **4**



Comparative material **5**

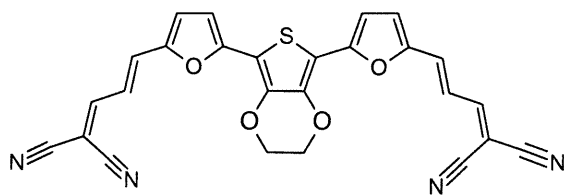


Comparative material **6**

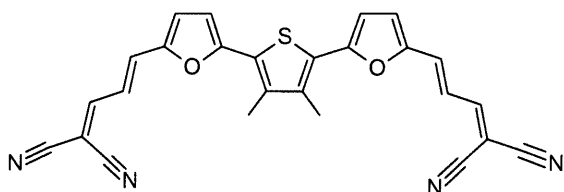
Comparative material **7**

("DCC3T", Fitzner, Adv. Funct. Mat. 2015, 25, 1845)

The comparative materials are similar in terms of structure to inventive compounds **23** and **8**:



5

Compound **23**Compound **8**

Compound	OD _{max}	OD integral (400-900 nm)	FWHM
Comparative material 3	0.45	101	209
Comparative material 4	0.4	89	212
Comparative material 5	0.42	104	251
Comparative material 6	0.38	92	257
Comparative material 7	0.45	84	192
Compound 23	0.45	134	345
Compound 8	0.42	106	284

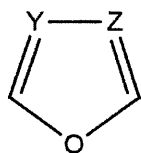
Table 6: Comparison of optical properties.

Table 6 compares the optical density (OD_{max}, OD integral and the corresponding full width at half maximum FWHM) of inventive compounds (compound **23** and compound **8**) with a series of comparative materials having similar structure. Optical density is a measure of absorption intensity.

Of the compounds shown, compound **23** and compound **8** have the best optical properties. More particularly, the highest full widths at half maximum under the given conditions were obtained for these compounds, as were the highest values for the OD integral. This
5 indicates particularly good utilization of photons from the entire visible spectrum.

Compound **23** differs from comparative material 5, as does compound 8 from comparative material **6**, in that the compounds of the invention each have outer five-membered rings having oxygen rather than sulfur.
10 The better optical properties observed are thus attributable to the structural difference. Thus, for instance, a furan is more suitable as an outer five-membered ring than a thiophene ring. This fact is also apparent through the comparison of inventive compound **8** with comparative material **7** known from the literature. These materials
15 differ both by different acceptor units and by the exchange of thiophene for furan, but only compound **8** simultaneously has a strong and broad absorption, which results in a significantly higher absorption integral, whereas, in the case of comparative material **6** containing thiophene rings only but simultaneously containing an
20 open-chain acceptor group, the absorption integral is only slightly higher. Thus, the effect can again be attributed to the advantageous presence of furan rings.

The inventors of the present invention have additionally found that said effect additionally requires an electron-withdrawing group on
25 said five-membered ring having at least two C=C double bonds. This is apparent, for example, from the comparison of comparative material **3** and comparative material **4**. Even though the latter has furan rings as five-membered rings, it does not exhibit improved optical properties. This is attributable to the fact that, in comparative material **4**,
30 there is only one acceptor group present on the furan ring with a single C=C double bond in conjunction with the furan unit. By contrast, the improved absorption properties require the combined presence of a structural unit

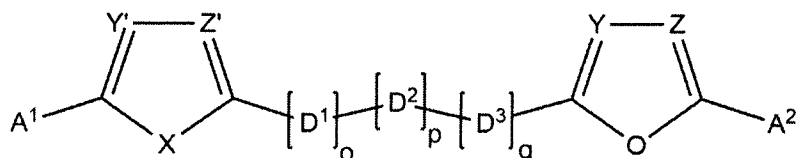


with an electron-withdrawing group A^2 that always has at least two C=C double bonds.

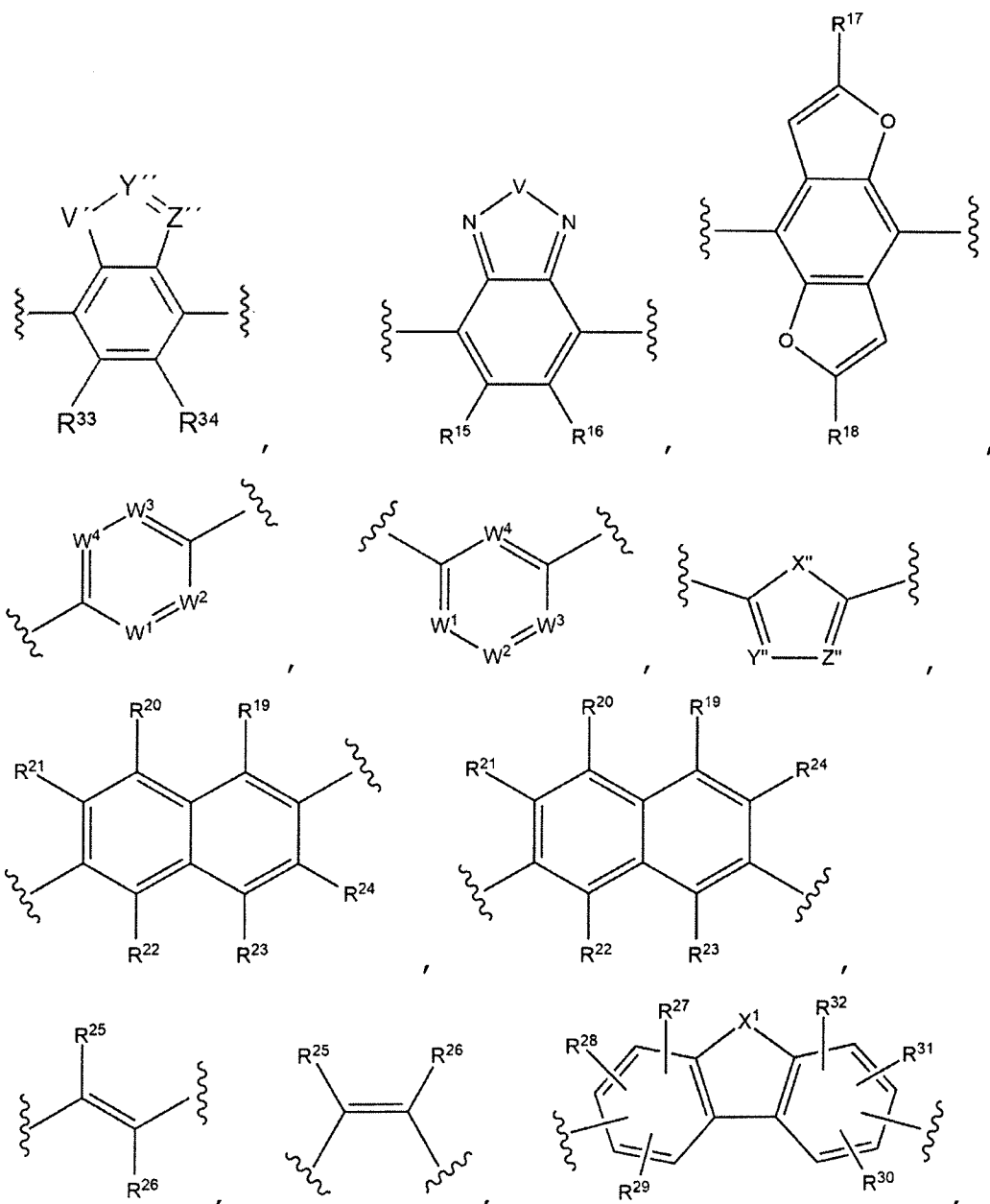
The invention is not restricted by the description with reference to
5 the working examples. Instead, the invention includes every new feature and every combination of features, especially including every combination of features in the claims, even if this feature or this combination itself is not specified explicitly in the claims or working examples.

Claims

1. A compound of the general formula (I):



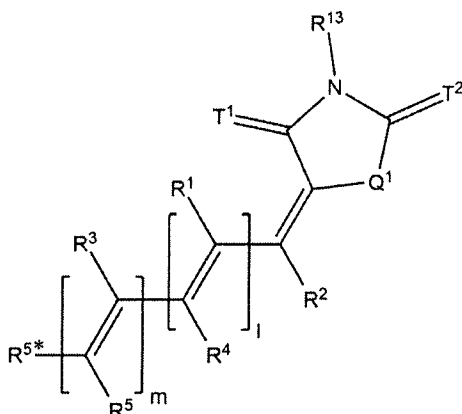
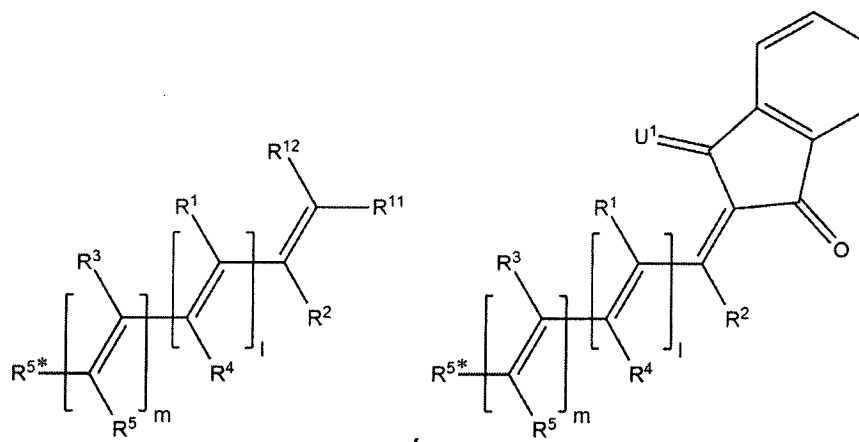
- 5 - with Y, Y', Z and Z' each independently selected from: N or CR^a,
- with X selected from: O, S, Se, Si(R^bR^c), P(R^b), P(O)R^b,
- where the R^a to R^c radicals are each independently selected from
- the group of the following radicals: H, halogen, CN, NR^dR^e where
- 10 R^d and R^e are each independently selected from the group of the
- radicals: H, and cyclic or open-chain C₁-C₂₀-alkyl, where
- individual carbon atoms may be replaced by heteroatoms and where
- hydrogen atoms in the alkyl radical may be substituted,
- cyclic or open-chain C₁-C₂₀-alkyl, where individual carbon atoms
- may be replaced by heteroatoms,
- 15 - cyclic or open-chain C₁-C₂₀-O-alkyl,
- cyclic or open-chain C₁-C₂₀-S-alkyl,
- cyclic or open-chain C₂-C₂₀-alkenyl,
- cyclic or open-chain C₂-C₂₀-O-alkenyl,
- cyclic or open-chain C₂-C₂₀-S-alkenyl,
- 20 - cyclic or open-chain C₂-C₂₀-alkynyl,
- aryl,
- heteroaryl,
- where hydrogen atoms in the alkyl, O-alkyl, S-alkyl, alkenyl, O-
- alkenyl, S-alkenyl, alkynyl, aryl and heteroaryl radicals may
- 25 each independently be substituted; and
- where A¹ is an electron-withdrawing radical having at least one
- C=C double bond, and
- where A² is an electron-withdrawing radical having at least two
- conjugated C=C double bonds, and
- 30 - where the conjugated D¹, D² and D³ blocks are each independently
- selected from the group of the following structural units:



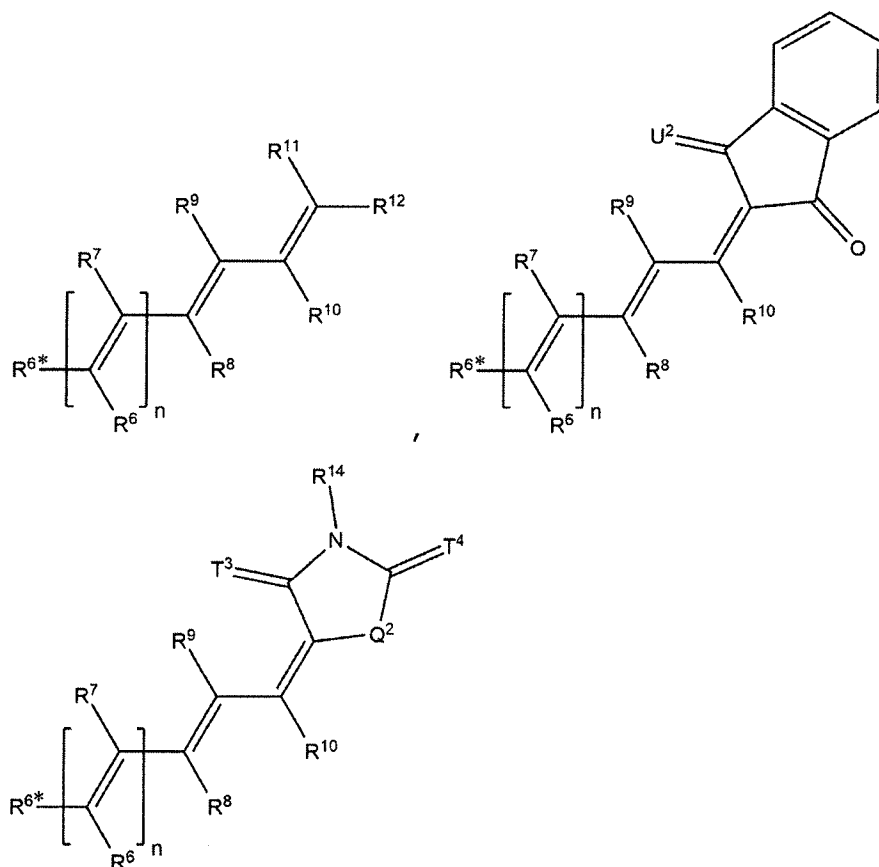
- 5 - where the coefficients o and q each independently assume the values of 0 and 1 and the coefficient p assumes the values of 0, 1, 2, 3, 4 and 5, with the proviso that at least one of the coefficients o, p and q is not 0,
- with Y'' selected from: N or CR^g;
- 10 - with Z'' selected from: N or CR^h;
- with X'' selected from: O, S, Se, Si(RⁱR^j), P(Rⁱ), P(O)Rⁱ;
- with V selected from: O, S, Se or NR^k;
- with V' selected from: O, S, Se or NR^k;
- with X¹ selected from: NR¹, CR¹R^m;
- 15 - with W¹ to W⁴ independently selected from: N, CRⁿ;

- where the R^g to R^n radicals and the R^{15} to R^{34} radicals are each independently selected from the group of the radicals as R^a to R^c ; and
 - where the R^g and R^h radicals may be joined to one another in the form of a ring structure and where an aryl radical may be fused onto the ring structure, where any aryl radical fused to the ring structure may be substituted.
2. A compound as claimed in the preceding claim, wherein exactly one of the three coefficients o, p and q is 1, while the two other coefficients are 0.

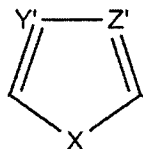
3. A compound as claimed in either of the preceding claims,
- where A^1 is selected from the group of the following radicals:



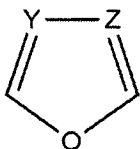
- where, in each of these three radicals for A^1 , either the E isomer or the Z isomer may each independently be present for each C=C double bond in each case, and
- where A^2 is selected from the group of the following radicals:



- where, in each of these three radicals for A², either the E isomer or the Z isomer may each independently be present for each C=C double bond in each case, and
 - where m, l and n are each independently 0 or 1,
 - where R¹ to R¹⁰ and R^{5*} and R^{6*} for the A¹ and A² groups are each independently selected from the group of the following radicals: H, halogen, CN, cyclic or open-chain C₁-C₂₀-alkyl, cyclic or open-chain C₂-C₂₀-alkenyl, cyclic or open-chain C₁-C₂₀-O-alkyl, aryl, heteroaryl, where hydrogen atoms in the alkyl, alkenyl, O-alkyl, aryl and heteroaryl radicals may each independently be substituted; and
- where it is possible in each case independently for a ring to be formed by the following pairs of radicals together: R¹ and R³, R² and R⁴, R⁴ and R⁵, R³ and R^{5*}, R⁷ and R⁹, R⁶ and R⁸, R⁸ and R¹⁰, R^{6*} and R⁷;
- with the proviso that, for A¹, exactly one of the R^{5*}, R⁵, R⁴, R³, R² and R¹ radicals represents a linkage $\frac{1}{2}$ by means of which A¹ is bonded to the structural element



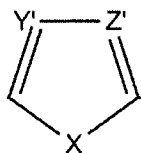
in the compound of the general formula (I), and with the proviso that, for A^2 , exactly one of the R^{6*} , R^6 , R^7 , R^8 , R^9 and R^{10} radicals represents a linkage -- by means of which A^2 is bonded to the structural element



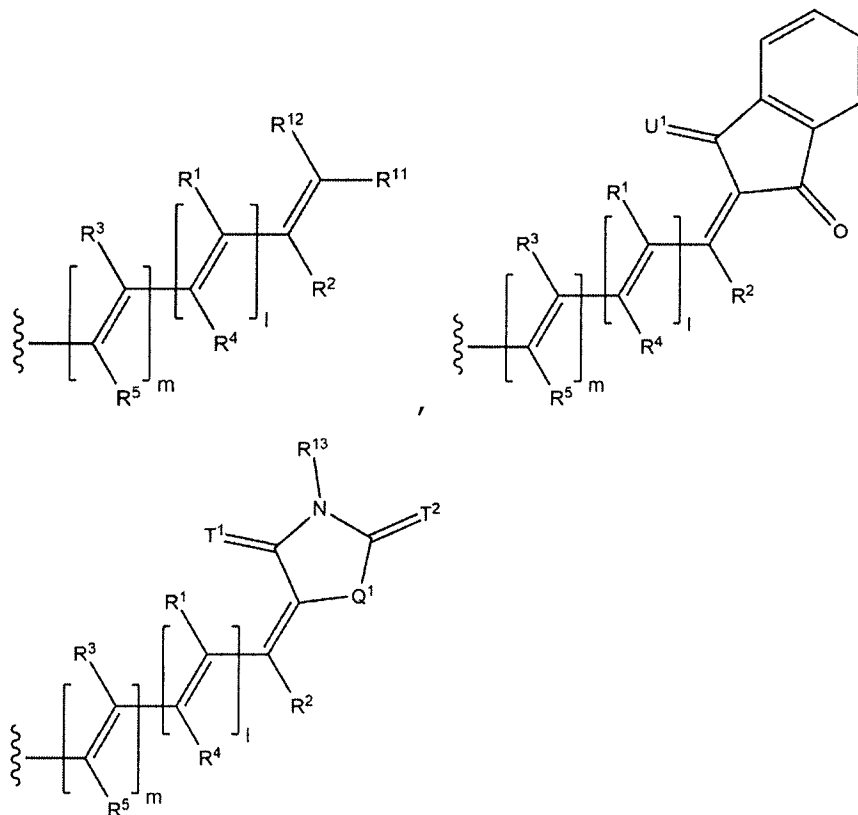
of the compound of the general formula (I);

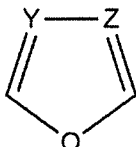
- where R^{11} and R^{12} for the A^1 and A^2 groups are each independently selected from the group of the radicals: H, CN, COOR^f where R^f is selected from the group of the radicals: H and cyclic or open-chain $\text{C}_1\text{--C}_{20}$ -alkyl, where hydrogen atoms in the alkyl may be replaced by fluorine atoms, with the proviso that R^{11} and R^{12} cannot both be H,
- where the R^{13} and R^{14} radicals are independently selected from the same group of radicals as R^d and R^e ; and
- where U^1 , U^2 , and T^1 to T^4 are each independently selected from the group consisting of: O, S and $\text{C}(\text{CN})_2$; and
- where Q^1 and Q^2 are each independently selected from the group consisting of: O and S.

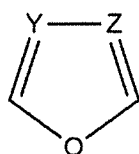
4. A compound as claimed in the preceding claim, wherein, for A^1 , the R^{5*} radical represents the linkage -- by means of which A^1 is bonded to the structural element



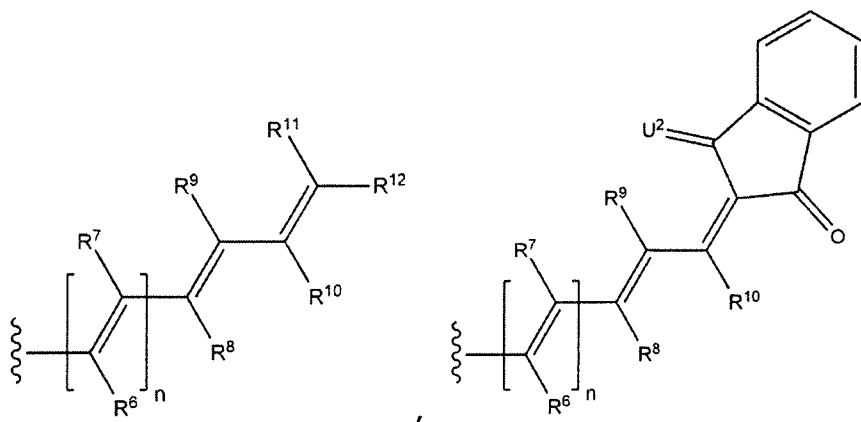
of the compound of the general formula (I), such that A^1 is selected from the group of the following radicals:

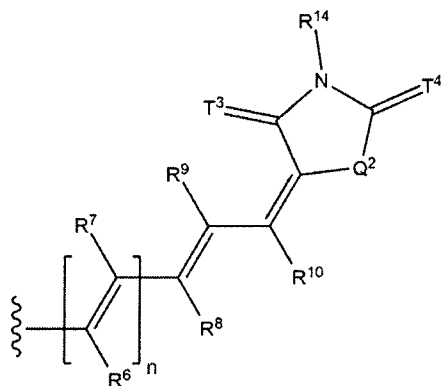


- where, in each of these three radicals for A¹, either the E isomer or the Z isomer may each independently be present for each C=C double bond in each case, and
- where, for A², the R^{6*} radical represents the linkage  by means of which A² is bonded to the structural element

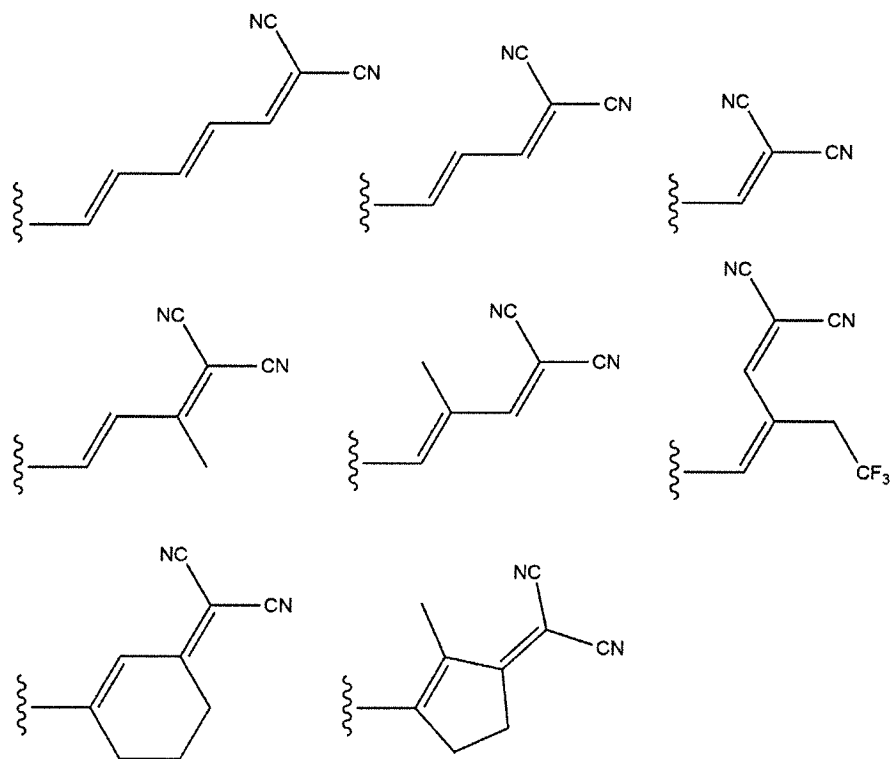


of the compound of the general formula (I), such that A² is selected from the group of the following radicals:

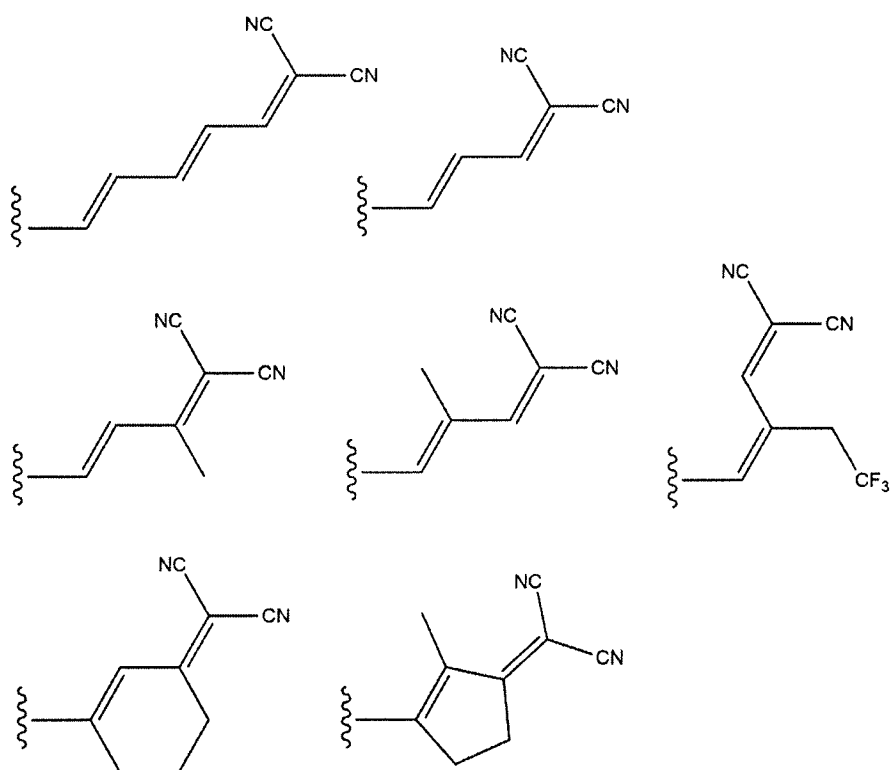




- where, in each of these three radicals for A^2 , either the E isomer or the Z isomer may each independently be present for each C=C double bond in each case.
- 5
5. A compound as claimed in either of claims 3 and 4, wherein the R^{11} and R^{12} radicals are each CN.
6. A compound as claimed in any of claims 3 to 5, wherein the R^1 to R^{10} and R^{5*} and R^{6*} radicals are each independently selected from the group of the following radicals: H, F, linear or branched C_1 - C_5 -alkyl, where hydrogens in the alkyl may each independently be replaced by fluorine atoms.
- 10
- 15 7. A compound as claimed in any of the preceding claims, wherein A^1 is selected from the group of the following radicals:

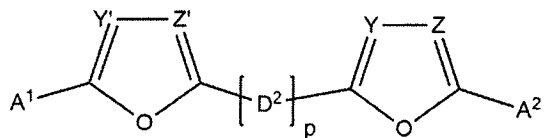


8. A compound as claimed in any of the preceding claims, wherein A²
 5 is selected from the group of the following radicals:



9. A compound as claimed in any of the preceding claims with X = oxygen.

10. A compound as claimed in any of the preceding claims with X = oxygen, with $m = n = 0$, with $o = q = 0$ and with p selected from: 1, 2, 3, 4 and 5, having the general formula:

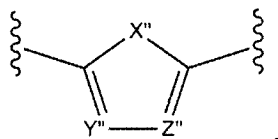


11. A compound as claimed in any of the preceding claims,
 10 - where Y, Y', Z and Z' are each independently selected from: N or CR^a,
 - where R^a is selected from the group of the following radicals:
 H, F, C₁-C₅-alkyl, C₁-C₅-O-alkyl, C₁-C₅-S-alkyl, C₂-C₅-alkenyl,
 C₂-C₅-O-alkenyl, C₂-C₅-S-alkenyl, C₂-C₅-alkynyl, phenyl, where
 15 hydrogen atoms in the alkyl, O-alkyl, S-alkyl, alkenyl, O-alkenyl, S-alkenyl, alkynyl and phenyl radicals may each independently be substituted.

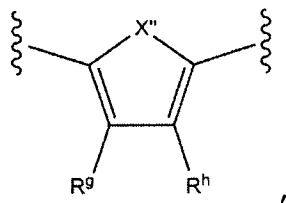
12. A compound as claimed in any of the preceding claims, wherein Y,
 20 Y', Z, Z' are each independently selected from: N, CH, C-F, C-CH₃, C-CF₃, C-C₂H₅, C-C₃H₈, C-OCH₃, C-OC₂H₅, C-SCH₃, C-SC₂H₅.

13. A compound as claimed in any of the preceding claims, wherein Y, Y', Z, Z' are each CH.

25 14. A compound as claimed in any of the preceding claims, wherein at least one of the conjugated D¹ to D³ blocks is present in the compound and has the general formula



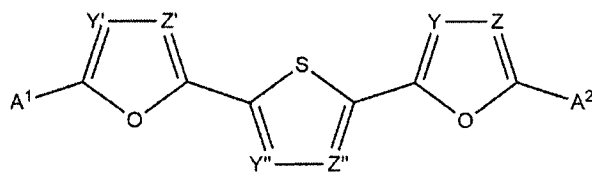
15. A compound as claimed in any of the preceding claims, wherein at least one of the conjugated D¹ to D³ blocks is present in the compound and has the general formula



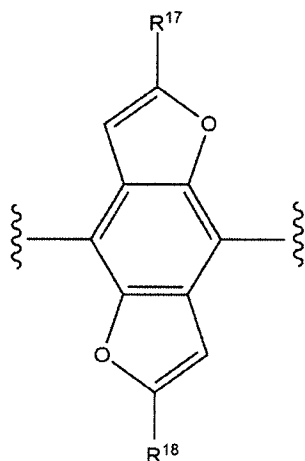
- 5 - where the R^g and R^h radicals are independently selected from the group of the following radicals: H, F, C₁-C₅-alkyl, where individual carbon atoms may be replaced by heteroatoms, C₁-C₅-O-alkyl, C₁-C₅-S-alkyl, where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be
- 10 substituted by fluorine,
- where the R^g and R^h radicals may be joined to one another in the form of a ring structure and where an aryl radical may be fused to the ring structure.

- 15 16. A compound as claimed in any of the preceding claims, wherein X'' = S.

17. A compound as claimed in the preceding claim having the following general formula:



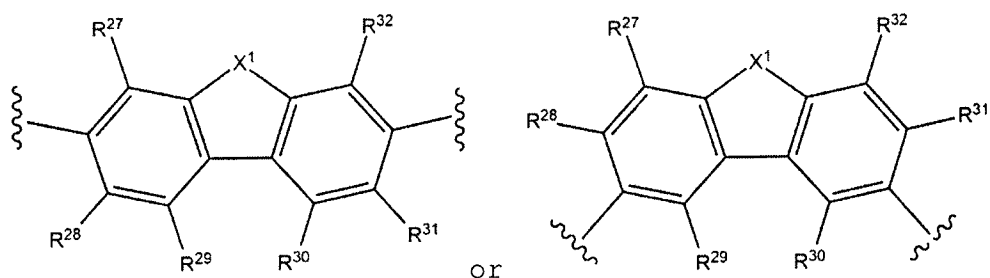
18. A compound as claimed in any of the preceding claims, wherein at least one of the conjugated D¹ to D³ blocks is present in the compound and has the general formula



- 5 - where R¹⁷ and R¹⁸ are each independently selected from the group of the following radicals: H, F, C₁-C₅-alkyl, C₁-C₅-O-alkyl, C₁-C₅-S-alkyl, where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms.

10

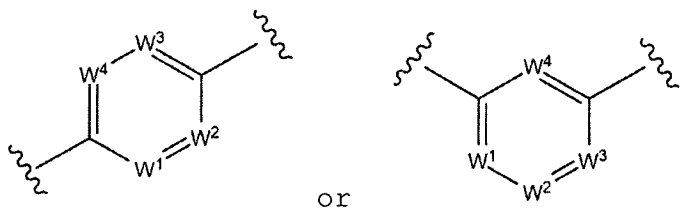
19. A compound as claimed in any of the preceding claims, wherein at least one of the conjugated D¹ to D³ blocks is present in the compound and has the general formula



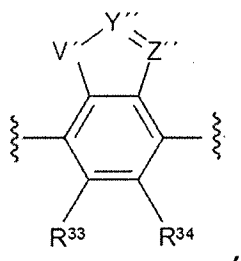
- 15 - where X¹ is selected from: NR¹, CR¹R^m,
 - where R¹ and R^m are each independently selected from the group of the radicals: H, open-chain C₁-C₅-alkyl, C₅-C₁₂-aryl, C₅-C₁₂-heteroaryl, where hydrogen atoms in the open-chain C₁-C₅-alkyl may at least partly be replaced by fluorine atoms and where
 20 hydrogen atoms in the C₅-C₁₂-aryl and the C₅-C₁₂-heteroaryl may at least partly be substituted, and
 - where R²⁷ to R³² are each independently selected from the group of the following radicals: H, F, C₁-C₅-alkyl, C₁-C₅-O-alkyl,

C₁-C₅-S-alkyl, where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms.

- 5 20. A compound as claimed in any of the preceding claims, wherein at least one of the conjugated D¹ to D³ blocks is present in the compound and has the general formula



- where W¹ to W⁴ are independently selected from: N and CRⁿ,
 - 10 - where Rⁿ is selected from the group of the following radicals: H, F, C₁-C₅-alkyl, C₁-C₅-O-alkyl, C₁-C₅-S-alkyl, where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms.
- 15 21. A compound as claimed in any of the preceding claims, wherein at least one of the conjugated D¹ to D³ blocks is present in the compound and has the general formula

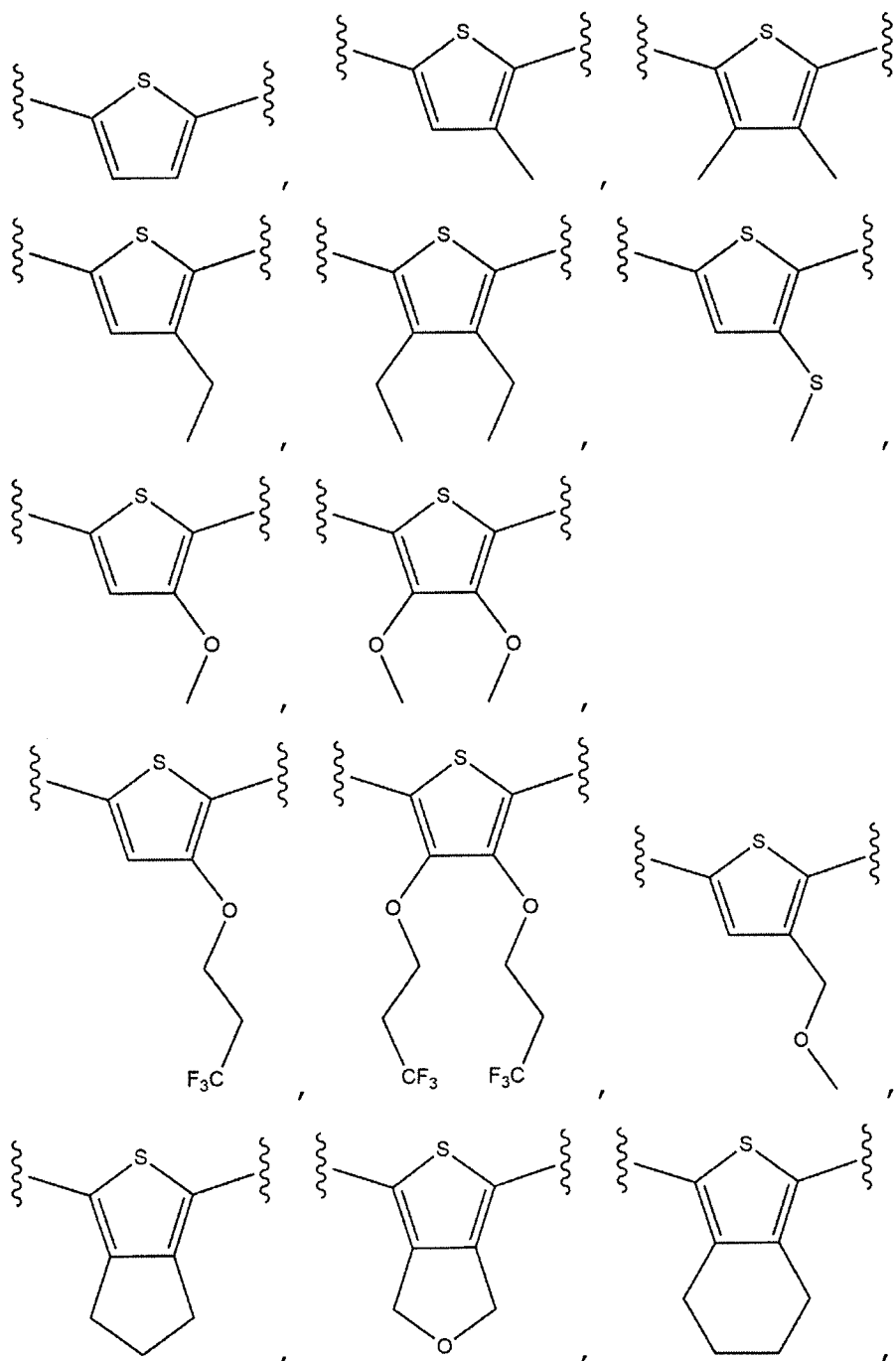


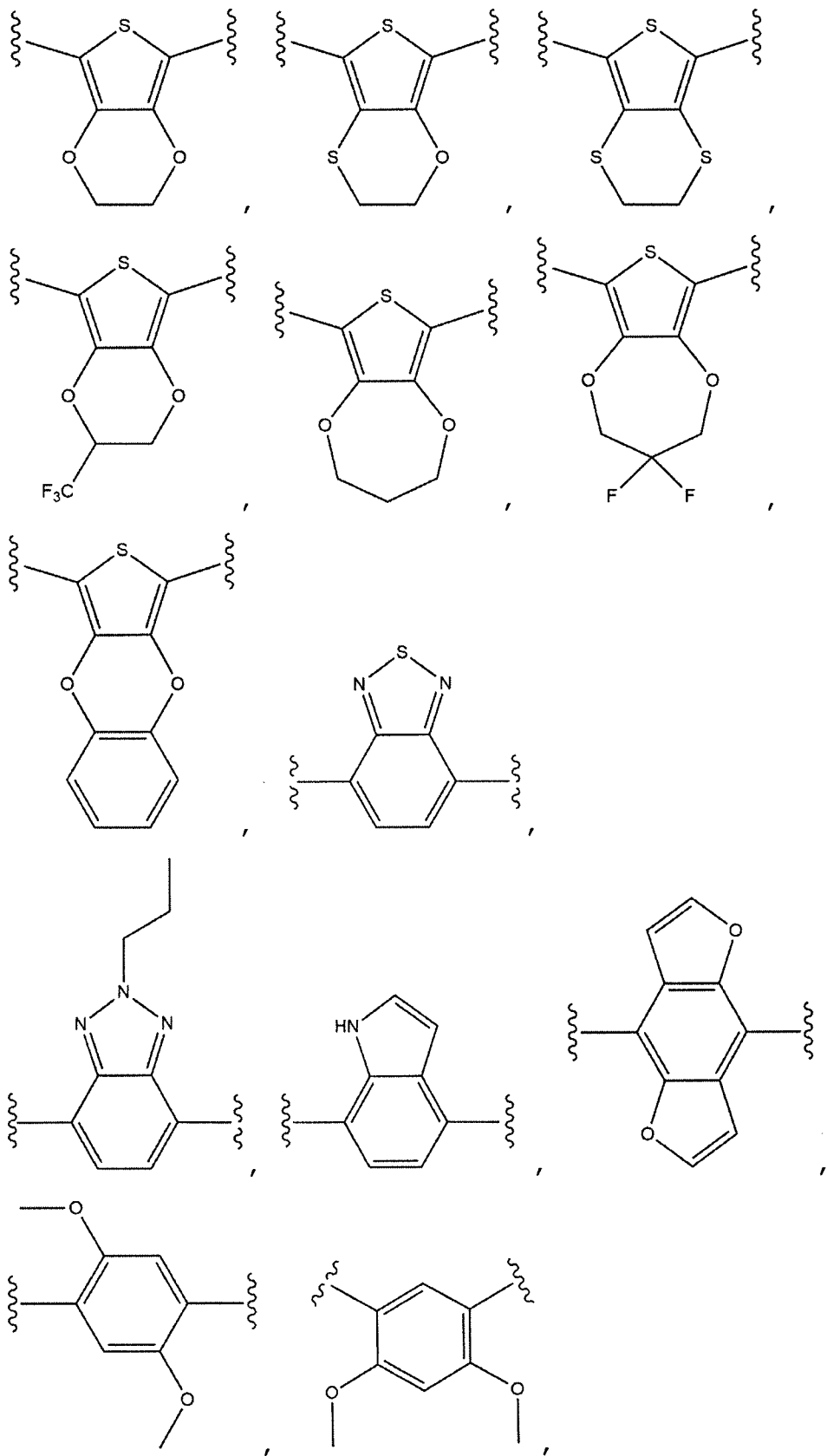
- where R³³ to R³⁴ are each independently selected from the group of the following radicals: H, F, C₁-C₅-alkyl, C₁-C₅-O-alkyl, C₁-C₅-S-alkyl, where hydrogen atoms in the alkyl, O-alkyl and S-alkyl radicals may each independently be replaced by fluorine atoms and
- with Y'' selected from: N or CR^g;
- 20 - with Z'' selected from: N or CR^h;
- with V' selected from: O, S, Se or NR^k;
- 25 - where R^g and R^h selected as one of the R^a to R^c radicals,

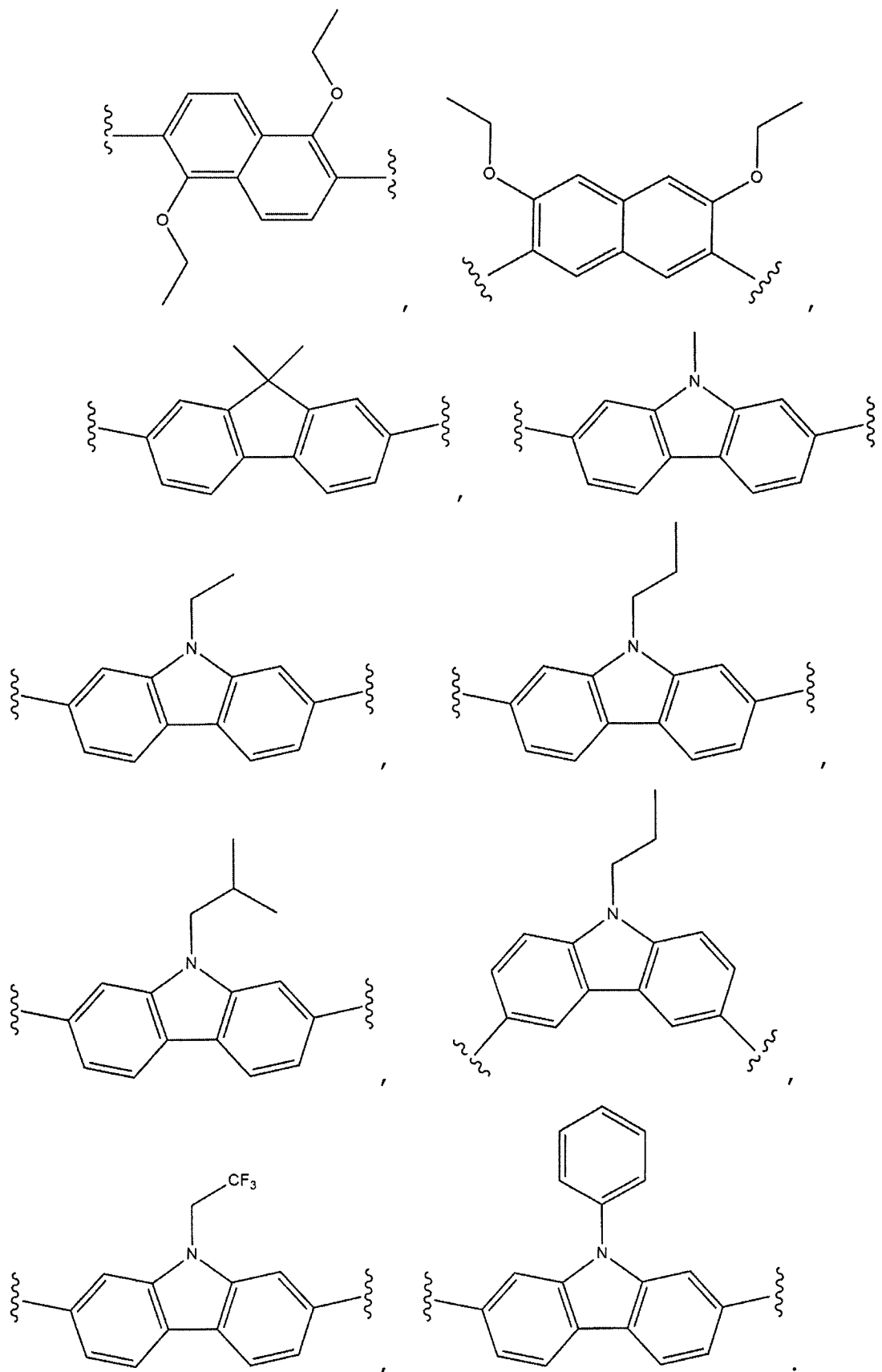
- where R^k is selected from the group of radicals: H, open-chain C_1 - C_5 -alkyl, C_5 - C_{12} -aryl, C_5 - C_{12} -heteroaryl, where hydrogen atoms in the open-chain C_1 - C_5 -alkyl may at least partly be replaced by fluorine atoms and where hydrogen atoms in the C_5 - C_{12} -aryl and the C_5 - C_{12} -heteroaryl may at least partly be substituted.

22. A compound as claimed in any of the preceding claims, wherein the conjugated D^1 to D^3 blocks are independently selected from the group of the following structural units:

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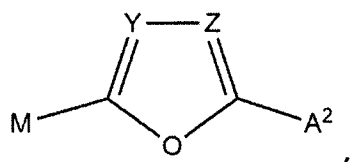


23. The use of one or more compounds as claimed in any of claims 1 to 22 in a photoactive organic electronic component.

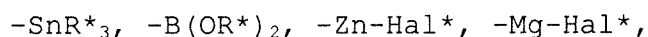
24. The use as claimed in the preceding claim, wherein the component
5 is an organic solar cell.

25. A photoactive organic electronic component comprising a compound as claimed in any of claims 1 to 22.

10 26. A compound for the preparation of a compound as claimed in any of claims 1 to 22, having the following general formula



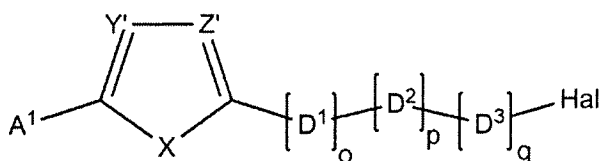
15 - where Y, Z and A² are as defined in any of the preceding claims and where M is selected from one of the following functional groups:



- where R* is a C₁-C₁₀-alkyl and where the Hal* group is a halogen.

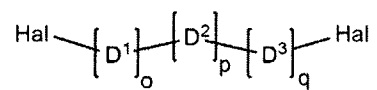
20 27. A process for preparing a compound as claimed in any of claims 1 to 22, comprising, as a process step, a coupling reaction

- wherein either
the compound of claim 26 reacts with a further compound of the following general formula



25 where A¹, Y', Z', X, D¹ to D³ and o, p and q are defined as defined in any of the preceding claims, and where the Hal group is a halogen,

- or
two equivalents of the compound of claim 26 are reacted with a
30 further compound of the following general formula



where D^1 to D^3 , o , p and q are as defined in any of the preceding claims, and where the Hal group is a halogen.