Claims

1. A polymerizable compound, represented by Formula (1):

$$P^1\text{-}Sp^1\text{-}(MG\text{-}Sp^1)_m\text{-}P^1 \qquad \text{Formula (1)}$$

wherein:

m is an integer from 2 to 60;

P^1 denotes a polymerizable group (P);

Sp^1 denotes at each occurrence

Sp'-X';

Sp' denotes

(a) $C_{1\text{-}40}$-straight chain alkylene or $C_{3\text{-}40}$-branched chain alkylene, each of which is optionally mono- or polysubstituted by F, Cl, Br, I or CN and in which, in addition, one or more non-adjacent CH_2 groups may each be replaced, independently of one another, by -O-, -S-, -NH-, -NR^{01}-, -$SiR^{01}R^{02}$-, -CO-, -COO-, -OCO-, -OCO-O-, -S-CO-, -CO-S-, -NR^{01}-CO-O-, -O-CO-NR^{01}-, -NR^{01}-CO-NR^{01}-, or -CH=CH- in such a way that O and/or S atoms are not linked directly to one another, or

(b) -Sp^x-G-Sp^y-, wherein Sp^x and Sp^y denote independently of each other $C_{1\text{-}20}$-alkylene or a single bond; G denotes $C_{3\text{-}20}$-cycloalkylene which is optionally mono- or polysubstituted by $C_{1\text{-}20}$-alkyl;

X' denotes -O-, -S-, -CO-, -COO-, -OCO-, -O-COO-, -CO-NR^{01}-, -NR^{01}-CO-, -NR^{01}-CO-NR^{01}-, -OCH_2-, -CH_2O-, -SCH_2-, -CH_2S-, -CF_2O-, -OCF_2-, -CF_2S-, -SCF_2-, -CF_2CH_2-, -CH_2CF_2-, -CF_2CF_2-, -CH=N-, -N=C-, -N=N-, -CH=CR^{01}-, -CY^{01}=CY^{02}-, -CH=CH-COO-, -OCO-CH=CH- or a single bond;

R^{01} and R^{02} each, independently of one another, denote H or C_{1-12}-alkyl; and

Y^{01} and Y^{02} each, independently of one another, denote H, F, Cl or CN;

MG is a rod-shaped mesogenic group, which is selected from Formula (2):

$$-(A^{21}-Z^{21})_k-A^{22}-(Z^{22}-A^{23})_l- \qquad \text{Formula (2)}$$

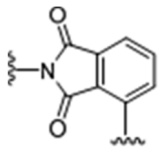
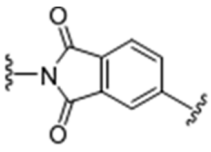
wherein:

A^{22} is at each occurrence independently of one another an aryl group, heteroaryl group, heterocyclic group, alicyclic group optionally being substituted by one or more identical or different groups L, or a cyclic imide group selected from the group consisting of:

, and ;

where one or more H atoms may be replaced by a group L, and/or one or more double bonds may be replaced by single bonds, and/or one or more CH groups may be replaced by N;

A^{21} and A^{23} are independently and at each occurrence independently of one another a cyclic imide group selected from the group consisting of:

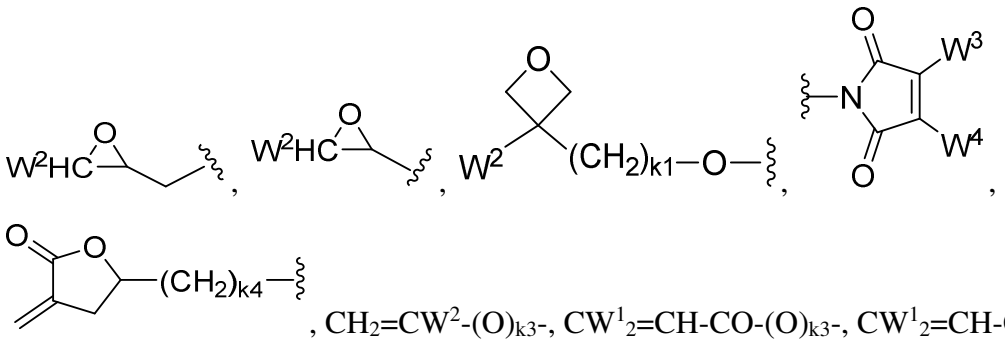
 , and  ;

Z^{21} and Z^{22} are independently and at each occurrence independently from each other, -O-, -S-, -CO-, -COO-, -OCO-, -S-CO-, -CO-S-, -O-COO-, -CO-NR^{01}-, -NR^{01}-CO-, -NR^{01}-CO-NR^{02}, -NR^{01}-CO-O-, -O-CO-NR^{01}-, -OCH_2-, -CH_2O-, -SCH_2-, -CH_2S-, -CF_2O-, -OCF_2-, -CF_2S-,

	$-SCF_2-$, $-CH_2CH_2-$, $-(CH_2)_4-$, $-CF_2CH_2-$, $-CH_2CF_2-$, $-CF_2CF_2-$, -CH=N-, -N=CH-, -N=N-, $-CH=CR^{01}-$, $-CY^{01}=CY^{02}-$, -C≡C-, -CH=CH-COO-, -OCO-CH=CH-, or a single bond;
L	is F, Cl, Br, I, -CN, $-NO_2$, -NCO, -NCS, -OCN, -SCN, $-C(=O)NR^{xx}R^{yy}$, $-C(=O)OR^{xx}$, $-C(=O)R^{xx}$, $-NR^{xx}R^{yy}$, -OH, $-SF_5$, or straight chain alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy with 1 to 20 C atoms, or branched chain alkyl, alkoxy, alkylcarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy with 3 to 20 carbon atoms, wherein one or more H atoms are optionally replaced by F or Cl, -CN straight chain alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy with 1 to 6 C atoms, or branched chain alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy with 3 to 6 carbon atoms;
R^{xx} and R^{yy}	independently of each other denote H or alkyl with 1 to 12 C-atoms; and
k and l	are each and independently 1, 2, 3 or 4.

2. The polymerizable compound according to claim 1, wherein the polymerizable groups P are groups containing a C=C double bond or C≡C triple bond, or groups which are suitable for polymerization by a ring-opening reaction.

3. The polymerizable compound according to claim 1, wherein the polymerizable groups P are $CH_2=CW^1-COO-$, $CH_2=CW^1-CO-$,



, $CH_2=CW^2-(O)_{k3}-$, $CW^1{}_2=CH-CO-(O)_{k3}-$, $CW^1{}_2=CH-CO-NH-$, $CH_2=CW^1-CO-NH-$, $CH_3-CH=CH-O-$, $(CH_2=CH)_2CH-OCO-$, $(CH_2=CH-CH_2)_2CH-OCO-$, $(CH_2=CH)_2CH-O-$, $(CH_2=CH-CH_2)_2N-$, $(CH_2=CH-CH_2)_2N-CO-$, $CH_2=CW^1-CO-NH-$, $CH_2=CH-(COO)_{k1}-Phe-(O)_{k2}-$, $CH_2=CH-(CO)_{k1}-Phe-(O)_{k2}-$, or Phe-CH=CH-,

wherein:

W^1	denotes H, F, Cl, CN, CF_3, phenyl or alkyl having 1 to 5 C atoms;
W^2	denotes H or alkyl having 1 to 5 C atoms;
W^3 and W^4	each, independently of one another, denote H, Cl or alkyl having 1 to 5 C atoms;
Phe	denotes 1,4-phenylene, which is optionally substituted by one or more radicals L as being defined above but being different from P-Sp; and
k_1, k_2 and k_3	each, independently of one another, denote 0 or 1; and
k_4	is an integer from 1 to 10.

4. The polymerizable compound according to claim 1, wherein each Sp^1 is independently $-(CH_2)_{p1}-$, $-(CH_2CH_2O)_{q1}-CH_2CH_2-$, $-CH_2CH_2-S-CH_2CH_2-$, $-CH_2CH_2-NH-CH_2CH_2-$, or $-(SiR^{01}R^{02}-O)_{p1}-$, wherein:

p1	is an integer from 1 to 60;
q1	is an integer from 1 to 12; and

R^{01} and R^{02} each, independently of one another, denote H or alkyl having 1 to 12 C atoms.

5. The polymerizable compound according to claim 1, wherein A^{22} denotes independently and, in case of multiple occurrence, independently of one another, a moiety of groups a) to e):

   a) trans-1,4-cyclohexylene, 1,4-cyclohexenylene and 4,4'-bicyclohexylene, in which one or more non-adjacent CH_2 groups may be replaced by -O- and / or -S- and wherein one or more H atoms may be replaced by a group L;

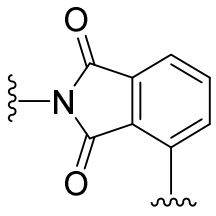
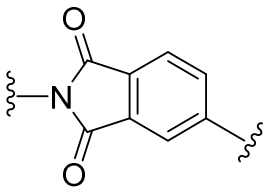
   b) 1,4-phenylene, 1,3-phenylene, 4,4'-biphenylene, 2,5-thiophene and 2,6-dithieno[3,2-b:2',3'-d]thiophene in which one or two CH groups may be replaced by N and where one or more H atoms may be replaced by a group L;

   c) tetrahydropyran-2,5-diyl, 1,3-dioxane-2,5-diyl, tetrahydrofuran-2,5-diyl, cyclobut-1,3-diyl, piperidine-1,4-diyl, thiophene-2,5-diyl and selenophen-2,5-diyl, which may be substituted one or more groups L;

   d) saturated, partially unsaturated or completely unsaturated, and optionally substituted, polycyclic radicals having 5 to 20 cyclic C atoms, of which one or more can also be replaced by heteroatoms,

      or

   e) cyclic imides:


, or

,

where one or more H atoms may be replaced by a group L, and/or one or more double bonds may be replaced by single bonds, and/or one or more CH groups may be replaced by N.

6. A method for forming a polymer comprising:

   (i) providing a polymerizable starting material comprising one or more polymerizable compounds according to claim 1; and
   (ii) polymerizing said polymerizable starting material.

7. The method forming a polymer according to claim 6, wherein the polymerizable starting material further comprises one or more additional polymerizable compounds selected from the group consisting of acrylates, epoxides, olefins, vinyl ethers, vinyl esters, polythiols and polyamines, which are capable of reacting with the polymerizable compound to form a copolymer.

8. The method forming a polymer according to claim 6, wherein the polymerizable starting material is polymerized in (ii) by radical or ionic polymerization or by exposure to radiation.

9. A polymer containing at least one repeating unit which is derived from the polymerizable compound of Formula (1) as defined in claim 1.

10. The polymer according to claim 9, wherein the repeating unit comprises a structural unit represented by Formula (4):

$$[\text{-Sp}^1\text{-(MG-Sp}^1)_m\text{-}] \qquad \text{Formula (4).}$$

11. An electronic device comprising a polymer according to claim 9.

12. The electronic device according to claim 11, wherein the polymer forms a dielectric layer.

13. A manufacturing method preparing a packaged microelectronic structure, in which a substrate is provided with a coating comprising one or more polymerized liquid crystalline monomers, wherein the method comprises:

(1) applying a polymerizable composition comprising one or more polymerizable compounds according to claim 1 to a surface of a substrate; and

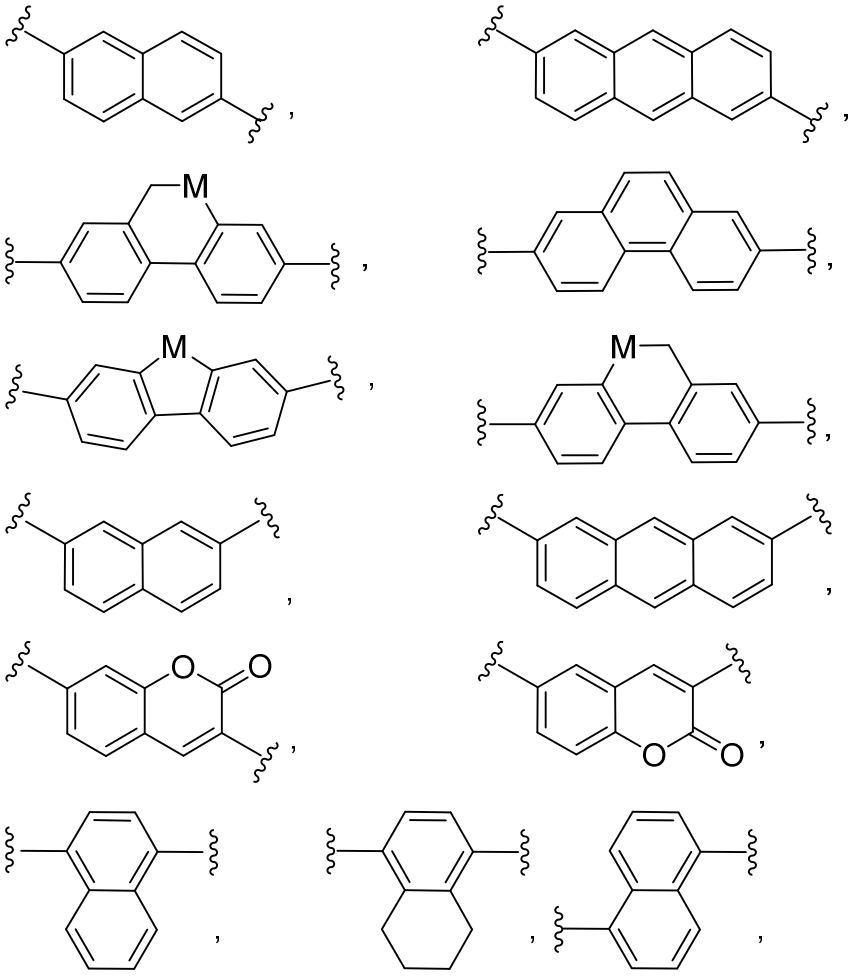
(2) curing said polymerizable composition to form a dielectric layer.

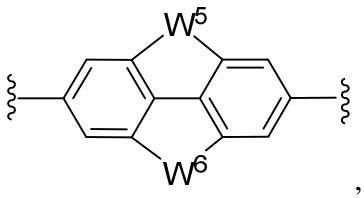
14. The manufacturing method preparing a packaged microelectronic structure according to claim 13, wherein the polymerizable composition further comprises one or more additional polymerizable compounds selected from the group consisting of acrylates, epoxides, olefins, vinyl ethers, vinyl esters, polythiols, and polyamines, which are capable of reacting with the polymerizable compound to form a copolymer.

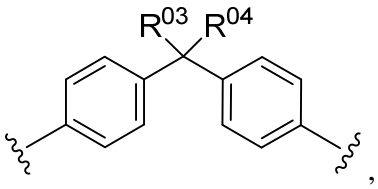
15. The manufacturing method preparing a packaged microelectronic structure according to claim 13, wherein the polymerizable composition further comprises one or more inorganic filler materials.

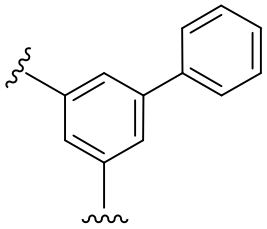
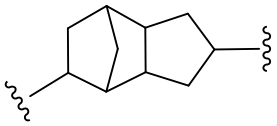
16. A microelectronic device comprising a packaged microelectronic structure comprising a polymer containing at least one repeating unit which is derived from the polymerizable compound of Formula (1) as defined in claim 1.

17. The polymerizable compound according to claim 5, wherein the d) saturated, partially unsaturated or completely unsaturated, and optionally substituted, polycyclic radicals having 5 to 20 cyclic C atoms, of which one or more can also be replaced by heteroatoms are bicyclo [1.1.1] pentane-1,3-diyl, bicyclo [2.2.2] octane-1,4-diyl, spiro [3.3] heptane-2,6-diyl, tricyclo [3.3.1.1] decane-1,3-diyl,





,


,

, or

,

where one or more H atoms may be replaced by a group L, and/or one or more double bonds may be replaced by single bonds, and/or one or more CH groups may be replaced by N, and where

M denotes -O-, -S-, -CH_2-, -CHY^{03}- or -$CY^{03}Y^{04}$-;

Y^{03}, Y^{04} denote independently of each other one of the meanings given above for R^{01}, F, Cl, CN, OCF_3 or CF_3;

W^5, W^6 denote independently of each other -CH_2CH_2-, -CH=CH-, -CH_2-O-, -O-CH_2-, -$C(R^cR^d)$- or -O-;

R^c, R^d denote independently of each other H or alkyl having 1 to 6 C atoms; and

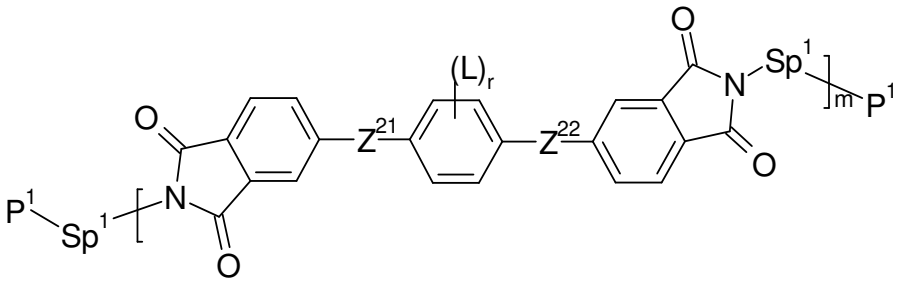
R^{03}, R^{04} denote independently of each other H, F, straight chain alkyl having 1 to 12 C atoms or branched chain alkyl having 3 to 12 C atoms, where one or more H atoms may be replaced by F.

18. The polymerizable compound according to claim 1, wherein m is an integer 12 to 60.

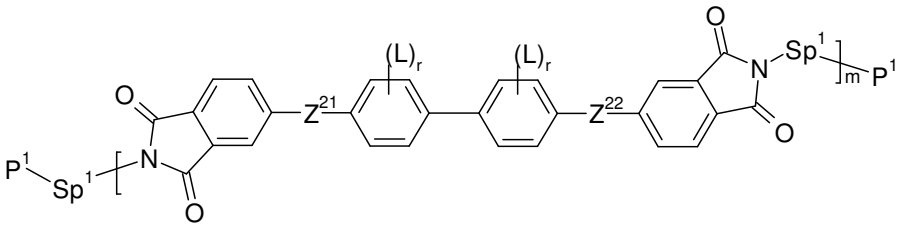
19. The polymerizable compound according to claim 1, wherein m is an integer from 20 to 60.

20. The polymerizable compound according to claim 1, wherein the polymerizable compound of formula (1) is selected from formulae M1 to M31 and M34c to M34f:

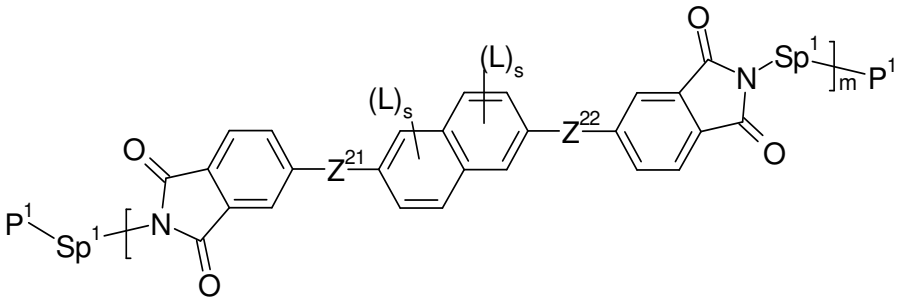
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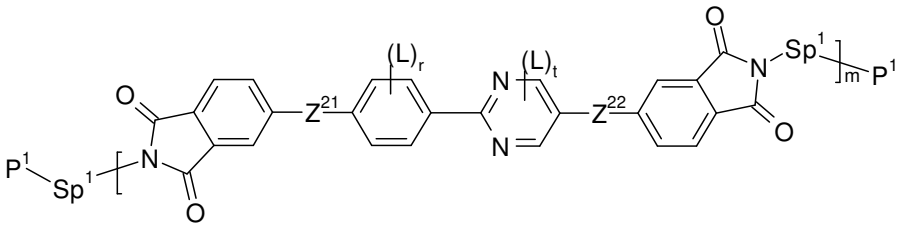
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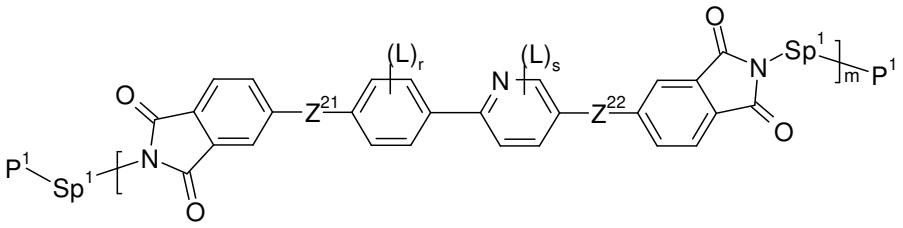
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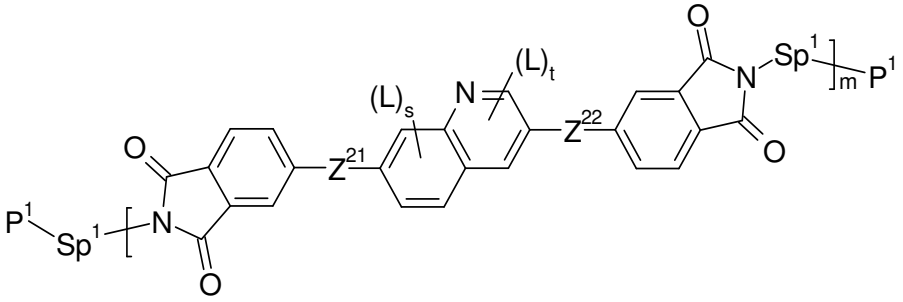
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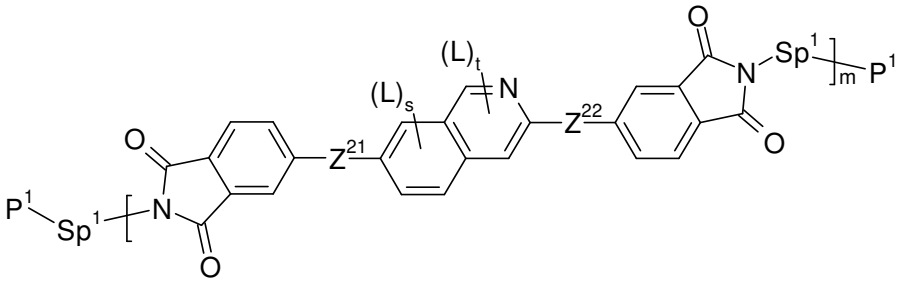
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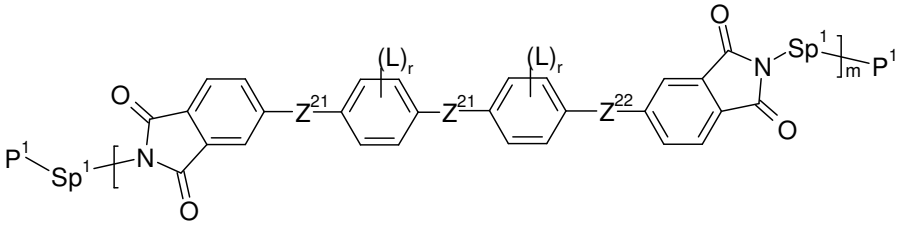
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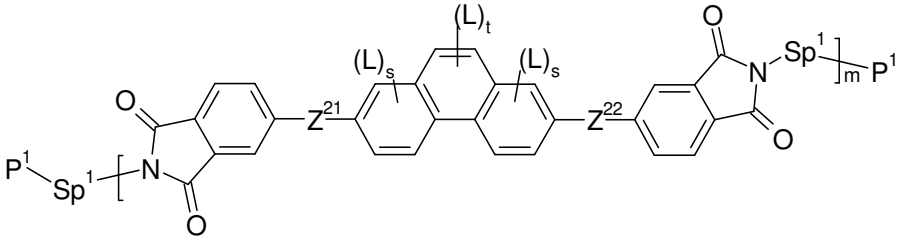
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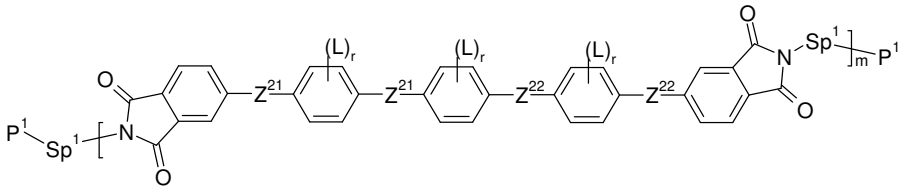
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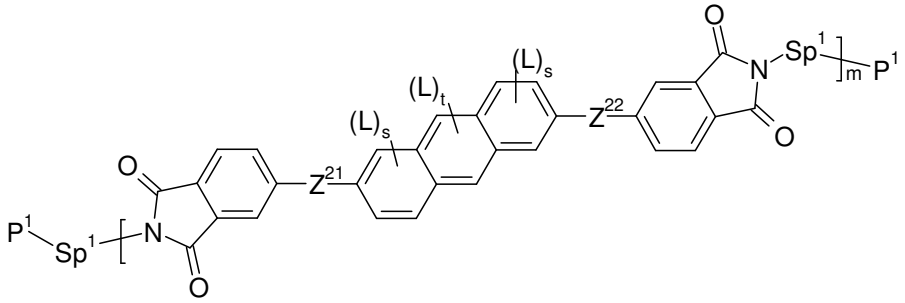
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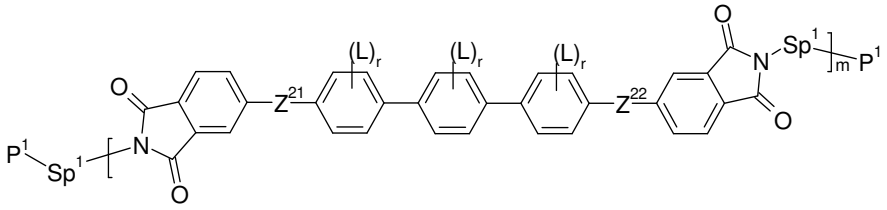
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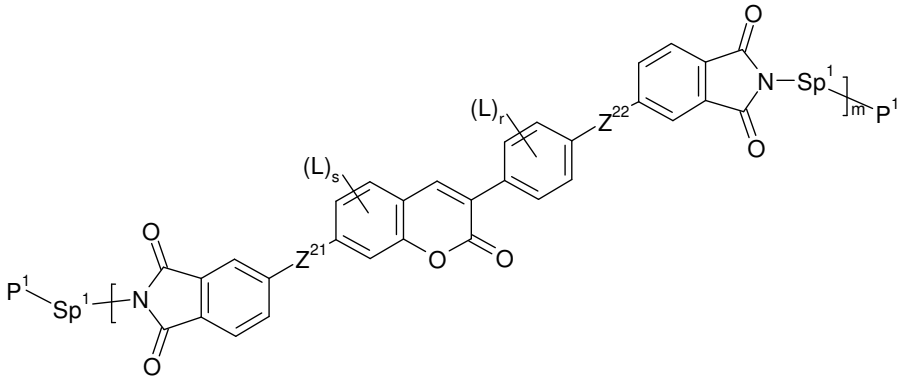
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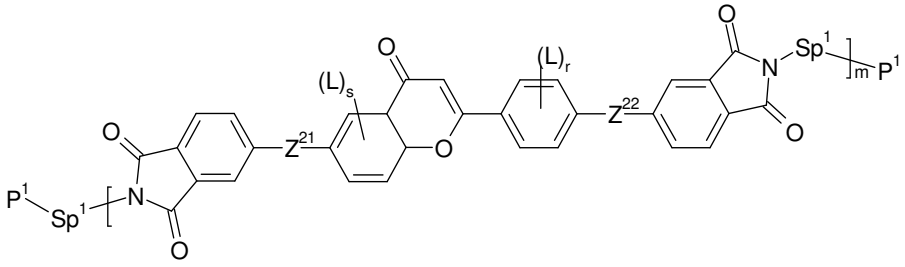
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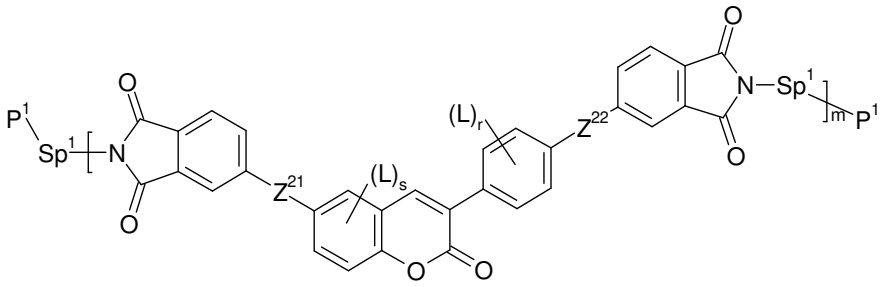
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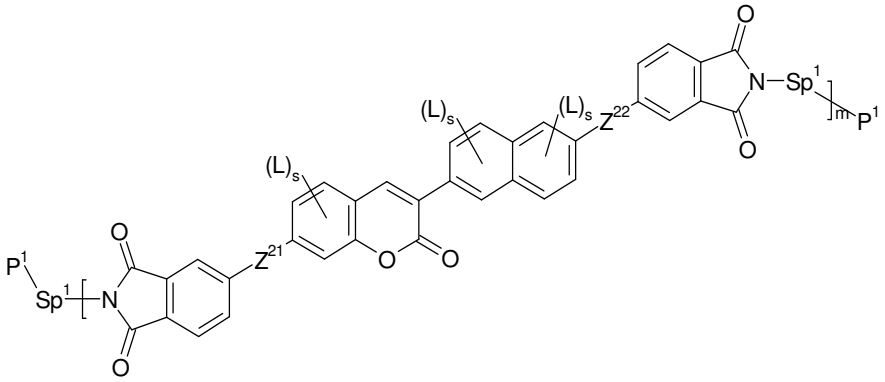
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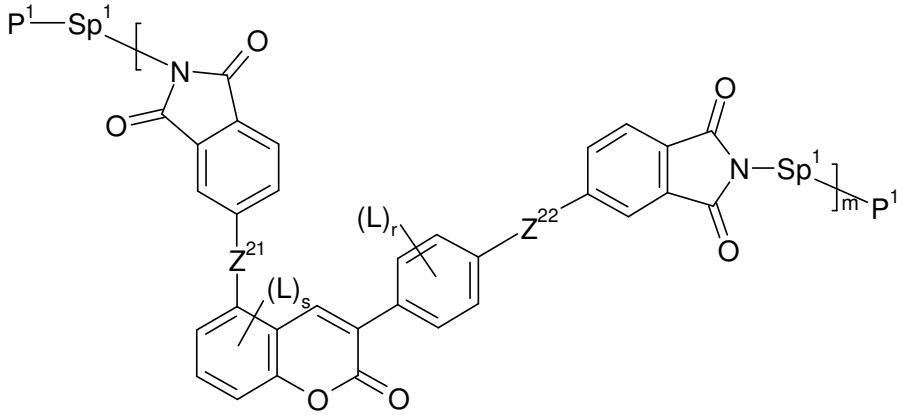
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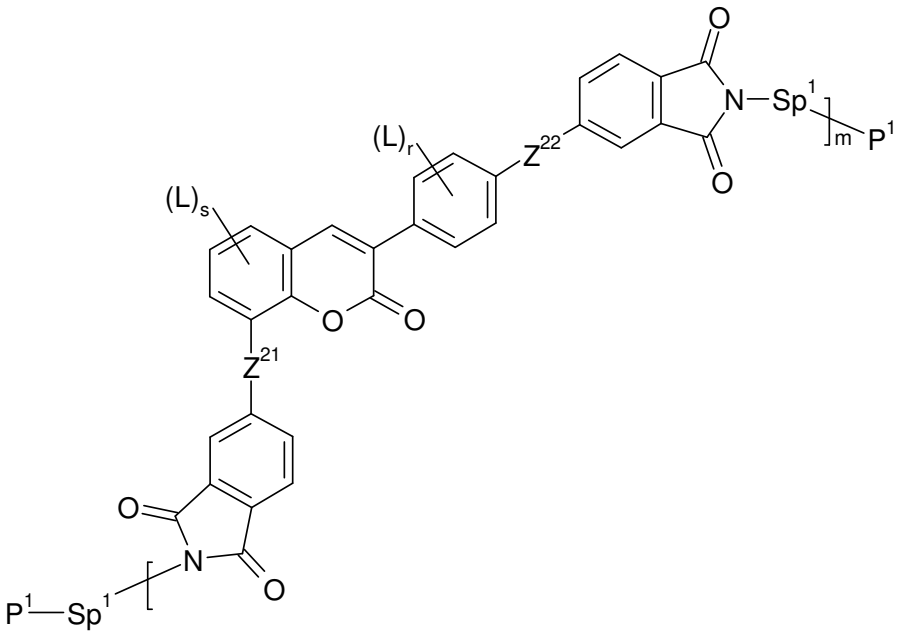
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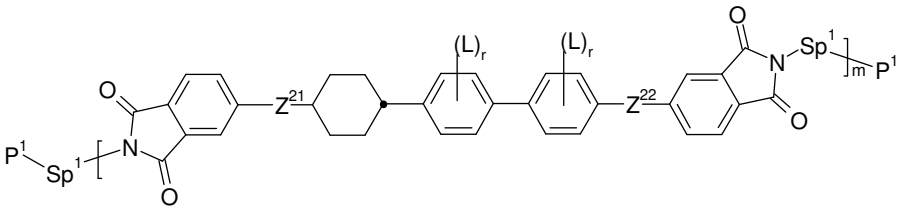
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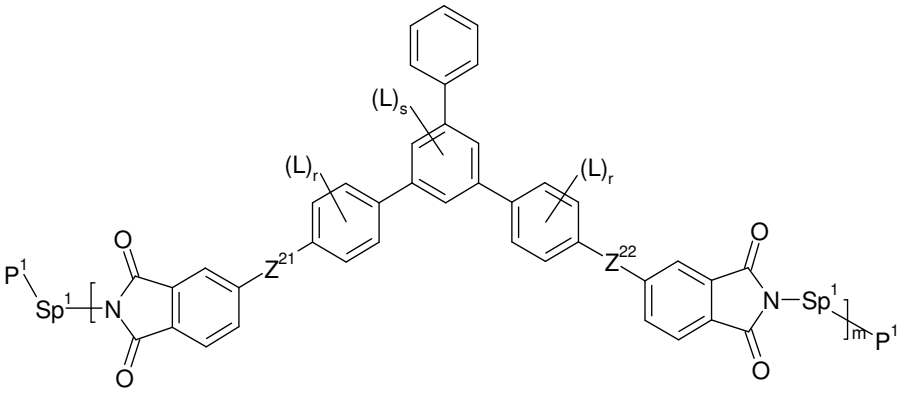
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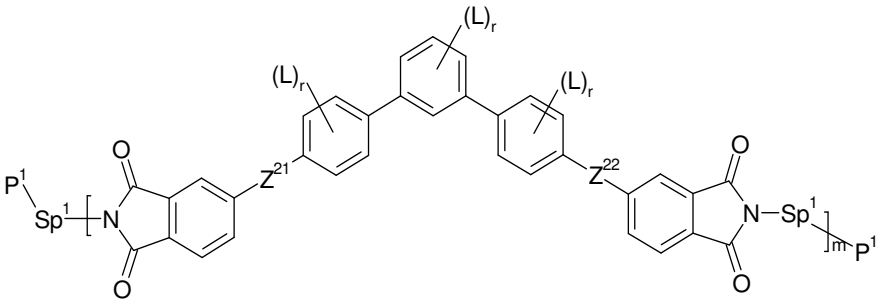
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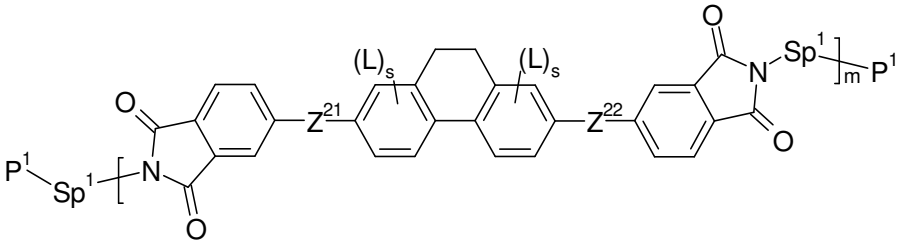
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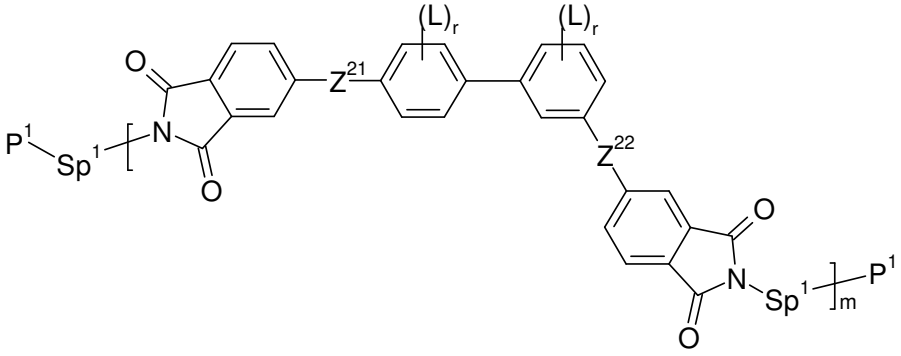
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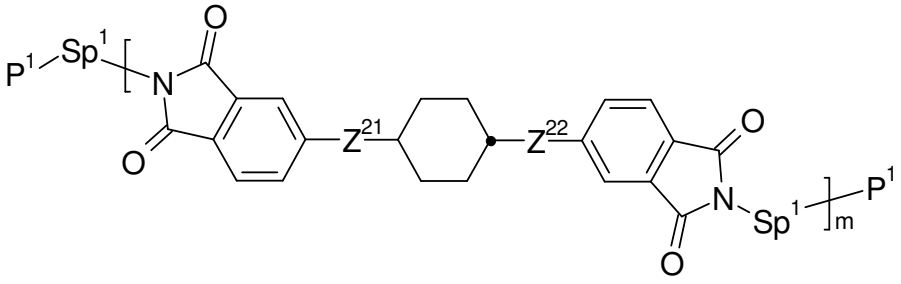
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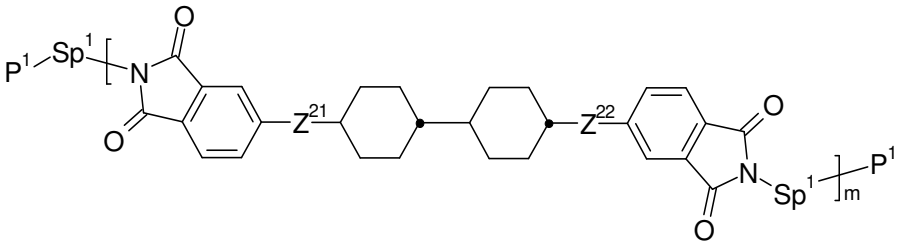
M23



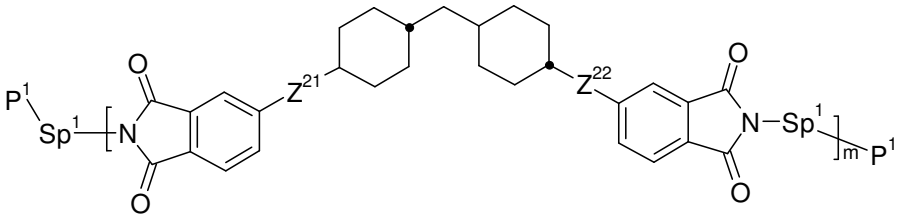
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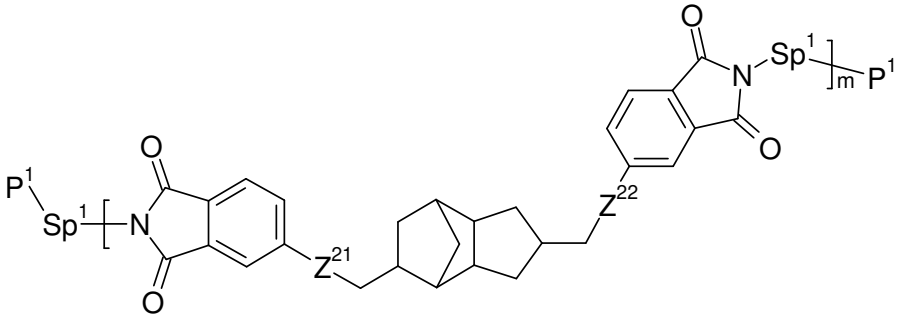
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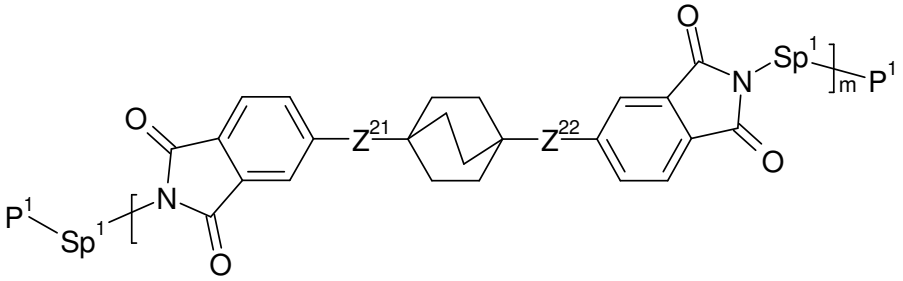
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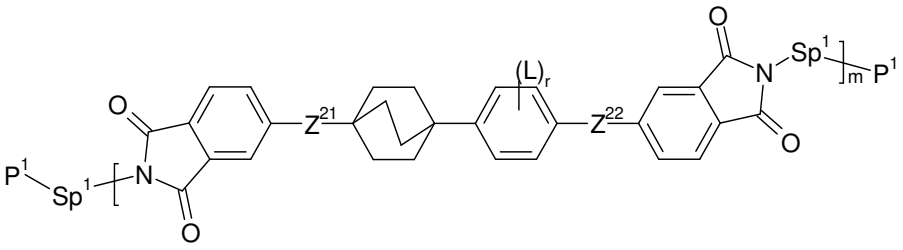
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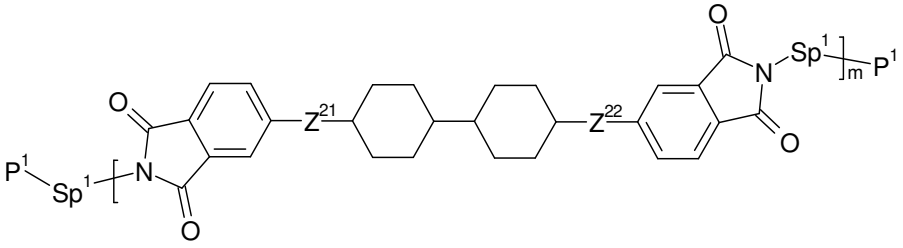
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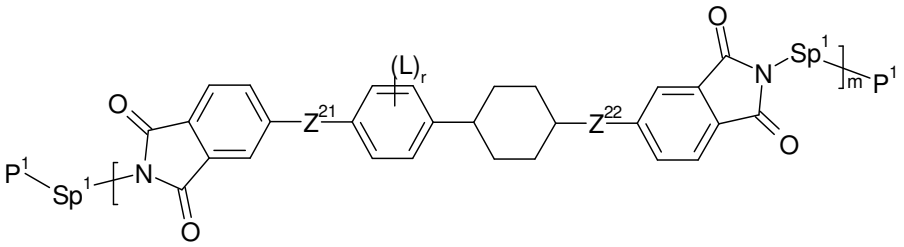


M29

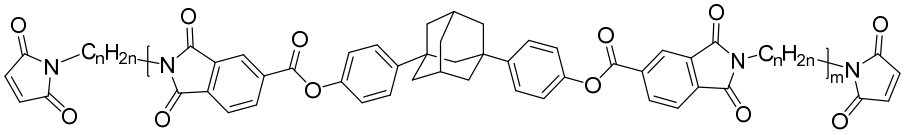


M30

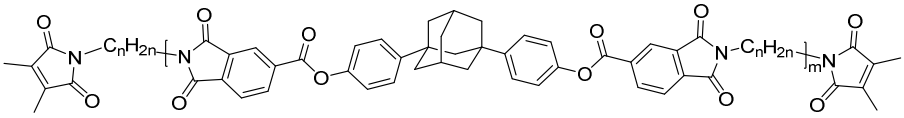




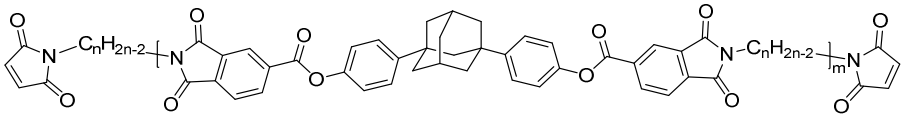
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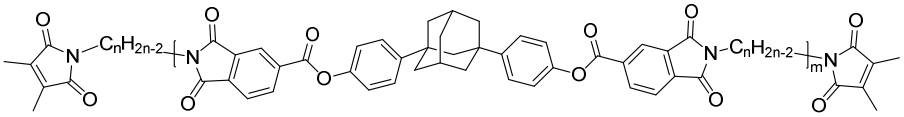
M34c



M34d



M34e



M34f

wherein:

L is F, Cl, Br, I, -CN, $-NO_2$, -NCO, -NCS, -OCN, -SCN, $-C(=O)NR^{xx}R^{yy}$, $-C(=O)OR^{xx}$, $-C(=O)R^{xx}$, $-NR^{xx}R^{yy}$, -OH, $-SF_5$, or straight chain alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy with 1 to 20 C atoms, or branched chain alkyl, alkoxy, alkylcarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy with 3 to 20 carbon atoms, wherein one or more H atoms are optionally replaced by F or Cl, -CN straight chain alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy with 1 to 6 C atoms, or branched chain alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy with 3 to 6 carbon atoms;

R^{xx} and R^{yy} independently of each other denote H or alkyl with 1 to 12 C-atoms;

r is 0, 1, 2, 3 or 4;

s is 0, 1, 2 or 3;

t is 0, 1 or 2;

Z^{21} and Z^{22} are independently and at each occurrence independently from each other, -O-, -S-, -CO-, -COO-, -OCO-, -S-CO-, -CO-S-, -O-COO-, -CO-NR^{01}-, -NR^{01}-CO-, -NR^{01}-CO-NR^{02}, -NR^{01}-CO-O-, -O-CO-NR^{01}-, -OCH_2-, -CH_2O-, -SCH_2-, -CH_2S-, -CF_2O-, -OCF_2-, -CF_2S-, -SCF_2-, -CH_2CH_2-, -$(CH_2)_4$-, -CF_2CH_2-, -CH_2CF_2-, -CF_2CF_2-, -CH=N-, -N=CH-, -N=N-, -CH=CR^{01}-, -CY^{01}=CY^{02}-, -C□C-, -CH=CH-COO-, -OCO-CH=CH-, or a single bond;

R^{01} and R^{02} each, independently of one another, denote H or alkyl having 1 to 12 C atoms;

Sp1 denotes at each occurrence Sp'-X';

Sp' denotes

a) C_{1-40}-straight chain alkylene or C_{3-40}-branched chain alkylene, each of which is optionally mono- or polysubstituted by F, Cl, Br, I or CN and in which, in addition, one or more non-adjacent CH_2 groups may each be replaced, independently of one another, by -O-, -S-, - NH-, -NR^{01}-, -$SiR^{01}R^{02}$-, -CO-, -COO-, -OCO-, -OCO-O-, -S-CO-, -CO-S-, -NR^{01}-CO-O-, -O-CO-NR^{01}-, -NR^{01}-CO-NR^{01}-, or -CH=CH- in such a way that O and/or S atoms are not linked directly to one another, or

b) -Sp^x-G-Sp^y-, wherein Sp^x and Sp^y denote independently of each other C_{1-20}-alkylene or a single bond; G denotes C_{3-20}-cycloalkylene which is optionally mono- or polysubstituted by C_{1-20}-alkyl;

X' denotes -O-, -S-, -CO-, -COO-, -OCO-, -O-COO-, -CO-NR^{01}-, -NR^{01}-CO-, -NR^{01}-CO-NR^{01}-, -OCH_2-, -CH_2O-, -SCH_2-, -CH_2S-, -CF_2O-, -OCF_2-, -CF_2S-, -SCF_2-, -CF_2CH_2-, -CH_2CF_2-, -CF_2CF_2-, -CH=N-, -N=C-, -N=N-, - CH=CR^{01}-, -CY^{01}=CY^{02}-, -CH=CH-COO-, -OCO-CH=CH- or a single bond;

Y^{01} and Y^{02} each, independently of one another, denote H, F, Cl or CN;

P^1 denotes a polymerizable group (P);

n is an integer from 1 to 60; and

m is an integer from 2 to 60.