~~Patent~~ CLAIMS

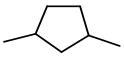
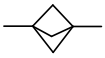
1. A compound of formula I

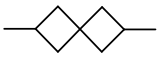
$$R^1\text{-}(A^1\text{-}Z^1)_r\text{-}B^1\text{-}Z^L\text{-}A^2\text{-}(Z^3\text{-}A^3)_s\text{-}G \qquad (I)$$

in which

R^1 denotes <u>one of:</u>

<u>a)</u> straight chain or branched alkyl or alkoxy radical having 1 to 20 C atoms, where one or more CH_2 groups in these radicals may each be replaced, independently of one another,

by -C≡C- , -CH=CH-,  , ,  ,  ,

 , -O-, -S-, -CF_2O-, -OCF_2-, -CO-O-, -O-CO- ,

-SiR^0R^{00}- , -NH- , -NR^0- or -SO_2- in such a way that O atoms are not linked directly to one another, and in which, in addition, one or more H atoms may be replaced by halogen, CN, SCN or SF_5,

<u>b)</u> ~~or alternatively, R^1 denotes~~ a group Dia-Z^D<u>, or</u>

<u>c) H,</u>~~.~~

Dia denotes a diamondoid radical,

Z^D has one of the meanings of Z^1 and Z^3 or denotes a straight chain or branched <u>Sp'-X'</u>~~spacer group~~<u>, wherein:</u>

<u>Sp′ denotes straight-chain or branched alkylene having 1 to 20, preferably 1 to 12 C atoms, 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—, —$NR^{0'}$—, —</u>

	$SiR^{00'}R^{000'}$—, —CO—, —COO—, —OCO—, —OCO—O—, —S—CO—, —CO—S—, —$NR^{0'}$—CO—O—, —O—CO—$NR^{0'}$—, —$NR^{0'}$—CO—$NR^{0'}$—, —CH=CH— or —C≡C— in such a way that O and/or S atoms are not linked directly to one another,
X′	denotes —O—, —S—, —CO—, —COO—, —OCO—, —O—COO—, —CO—$NR^{00'}$—, —$NR^{00'}$—CO—, —$NR^{00'}$—CO—$NR^{00'}$—, —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=CH—, —N=N—, —CH=$CR^{00'}$—, —CY^x=$CY^{x'}$—, —C≡C—, —CH=CH—COO—, —OCO—CH=CH—, or a single bond,
$R^{0'}$, $R^{00'}$, and $R^{000'}$	identically or differently, denote H or alkyl having 1 to 12 C atoms, and
Y^x and $Y^{x'}$	identically or differently, denote H, F, Cl or CN,

Z^1, Z^3	on each occurrence, identically or differently, denote a single bond, -CF_2O-, -OCF_2-, -CF_2S-, -SCF_2-, -CH_2O-, -OCH_2-, -C(O)O-, -OC(O)-, -C(O)S-, -SC(O)-, -$(CH_2)_{n1}$-, -$(CF_2)_{n2}$-, -CF_2-CH_2-, -CH_2-CF_2-, -CH=CH-, -CF=CF- , -CF=CH-, -CH=CF-, -$(CH_2)_{n3}O$-, -$O(CH_2)_{n4}$-, -C≡C-, -O-, -S-, -CH=N-, -N=CH-, -N=N-, -N=N(O)-, -N(O)=N- or -N=C-C=N-,
n1, n2, n3, n4	identically or differently, are 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10,
Z^L	denotes -O-, -S-, -CH_2-, -C(O)-, -CF_2-, -CHF-, -$C(R^x)_2$-, -S(O)- or -SO_2-,

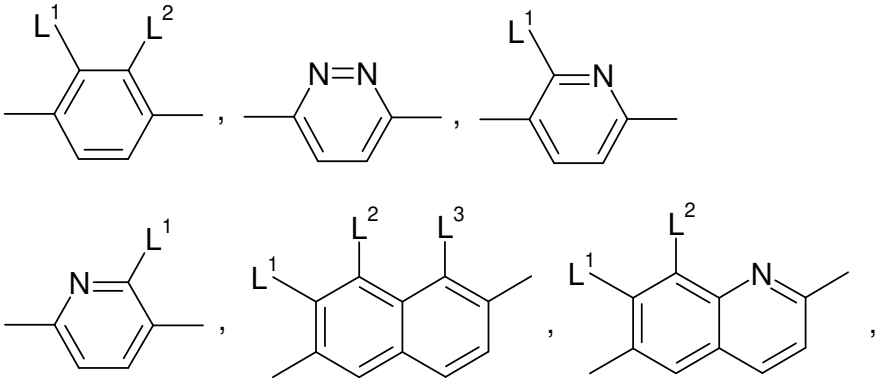
R^0, R^{00}, identically or differently, denote an alkyl or alkoxy radical having 1 to 15 C atoms, in which one or more H atoms may be replaced by halogen,

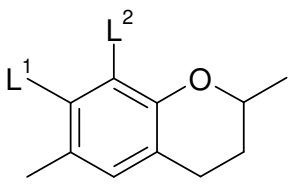
A^1, A^3 on each occurrence, identically or differently, denote an aromatic, heteroaromatic, alicyclic or heteroaliphatic ring having 4 to 25 ring atoms, which may also contain condensed rings and which may be mono- or polysubstituted by Y,

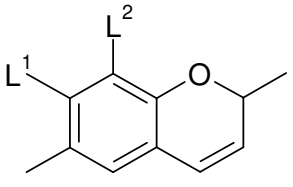
A^2 denotes an aromatic or heteroaromatic ring having 5 to 25 ring atoms, which may also contain condensed rings and which may be mono- or polysubstituted by Y,

Y on each occurrence, identically or differently, denotes F, Cl, CN, SCN, SF_5 or straight-chain or branched, in each case optionally fluorinated alkyl, alkoxy, alkylcarbonyl, alkoxycarbonyl, alkylcarbonyloxy or alkoxycarbonyloxy having 1 to 12 C atoms, or cycloalkyl or alkylcycloalkyl each having 3 to 12 C atoms, preferably methyl, ethyl, isopropyl, cylopropyl, cyclobutyl, cyclopentyl, cyclohexyl, trifluoromethyl, methoxy or trifluoromethoxy,

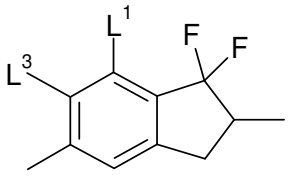
B^1 denotes

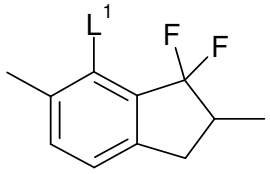


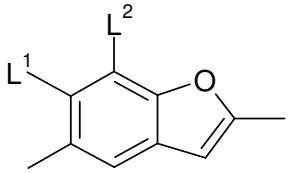


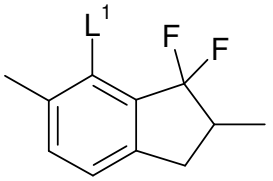
,


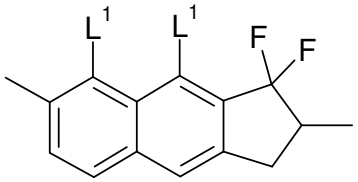
,



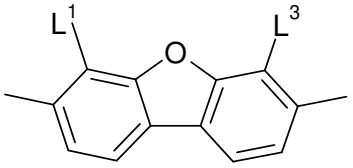
,


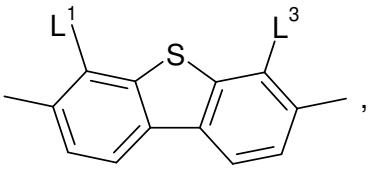
,




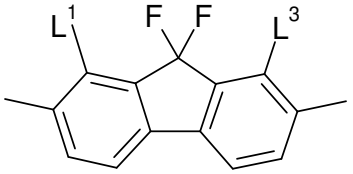
,


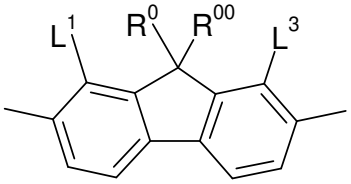
,



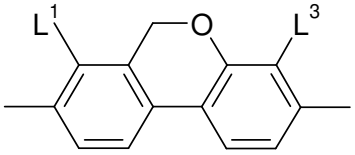
,


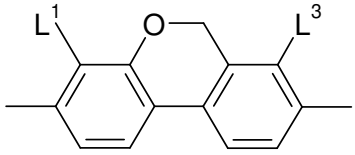
,

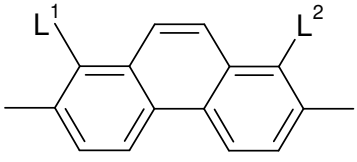


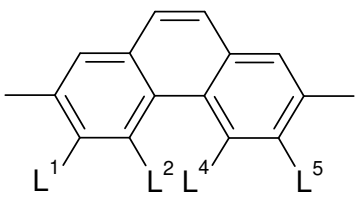
,


,



,




,


where the groups may be oriented in both directions,

L^1 to L^5, independently of one another, denote F, Cl, Br, I, CN, SF_5, CF_3 or OCF_3, preferably Cl or F, where L^3 alternatively denotes H,

G denotes $-CH=CH_2$, -OH, $-CH(CH_2OH)_2$, $-C(CH_2OH)_3$, $B(OH)_2$, -SH, $-SO_2OH$, $-OP(O)(OH)_2$, $-PO(OH)_2$, $-C(OH)(PO(OH)_2)_2$, -COOH, $-Si(OR^x)_3$ or $-SiCl_3$, $-SO_2OR^V$, $-OP(O)(OR^V)_2$, $-PO(OR^V)_2$, $-C(OH)(PO(OR^V)_2)_2$, $-COOR^V$, $-Si(OR^V)_3$,

R^V denotes alkyl having 1 to 20 C atoms, preferably secondary or tertiary alkyl having 3 to 10 C atoms,

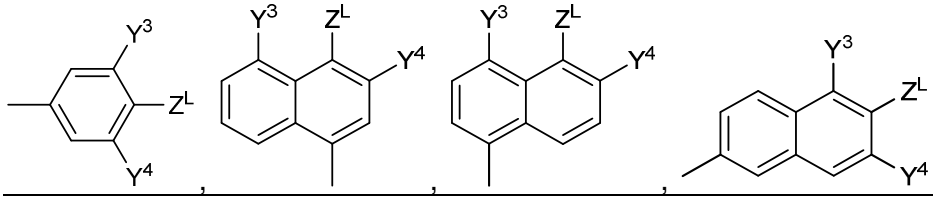
R^x denotes straight-chain or branched alkyl having 1 to 6 C atoms, and

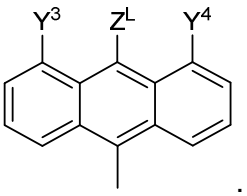
r is 0, 1 or 2,

s is 0, 1 or 2,

where $r + s \leq 4$, and

where A^2-Z^L denotes:

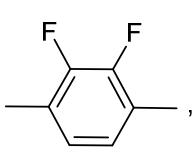


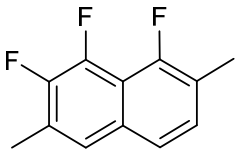


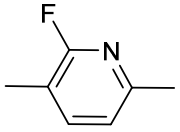
or .

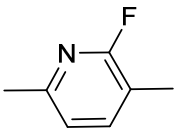
in which, Y^3 and Y^4, identically or differently, have the meanings given for Y.

2. The compound according to claim 1, wherein the group B^1 denotes

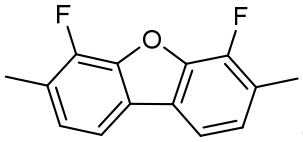


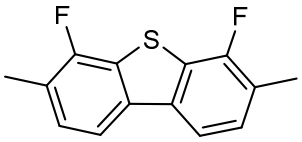
,


,


,


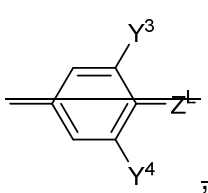
,

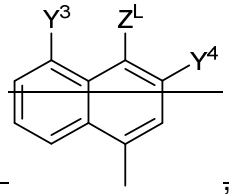


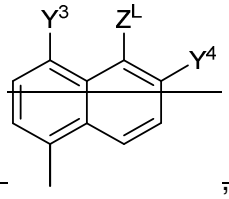
or


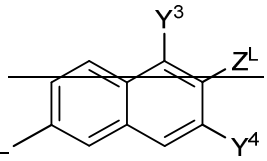
.

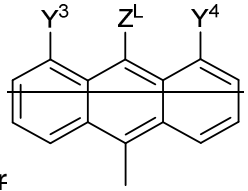
~~3. The compound according to claim 1 or 2, wherein A^2-Z^L denotes~~



,


,


,


,


~~or~~

~~in which~~

~~Y^3 and Y^4 identically or differently, have the meanings given for Y in claim 1 and~~

~~Z^L has the meanings given in claim 1.~~

~~4.~~3. The compound according to one or more of claims 1 to ~~3~~2, wherein A^1 and A^3, on each occurrence, identically or differently are selected from the following groups:

a) 1,4-phenylene, in which one or two CH groups may be replaced by N and in which, in addition, one or more H atoms may be replaced by Y,

b) the group consisting of trans-1,4-cyclohexylene and 1,4-cyclohexenylene, in which one or more non-adjacent CH_2 groups may be replaced by -O- and/or -S- and in which, in addition, one or more H atoms may be replaced by Y, and

c) the group consisting of 1,3-dioxolane-2,4-diyl, tetrahydrofuran-2,5-diyl, cyclobutane-1,3-diyl, 1,4-bicyclo[2.2.2]octanediyl, piperidine-1,5-diyl and thiophene-2,5-diyl, in which one or more H atoms may be replaced by Y,

where Y has the meanings given in claim 1.

~~5.~~4. The compound according to one or more of claims 1 to 4~~3~~, wherein R^1 denotes one of:

a) H,

b) straight chain or branched alkyl, alkenyl, alkynyl, or alkoxy each having up to 12 C atoms, ~~or~~

c) adamantyl, or

d) adamantylmethyloxy.

~~6.~~5. The compound according to one or more of claims 1 to ~~5~~4, wherein Z^L denotes -O-.

~~7.~~6. The compound according to one or more of claims 1 to ~~6~~5, wherein G denotes $-OP(O)(OH)_2$, $-PO(OH)_2$, $-C(OH)(PO(OH)_2)_2$.

~~8.~~7. The compound according to one or more of claims 1 to ~~7~~6, wherein s is 0.

~~9.~~8. The compound according to one or more of claims 1 to ~~8~~7, wherein Z^1 denotes a single bond.

~~10~~9. A process for the preparation of a switching element comprising at least the following steps:

a) production of a first electrode with a surface,

b) deposition of a molecular layer comprising one or more compounds of the formula I according to claim 1 onto the surface of the first electrode, and

c) application of a second electrode.

~~11~~10. The process according to claim ~~10~~9, wherein the first electrode comprises a material selected from the element semiconductors Si, Ge, C selected from diamond, graphite, graphene, Sn having alpha modification and Se, the compound semiconductors GaAs, InAs, InP, GaSb, TaN, TiN, MoN, WN and GaN, CdSe and ZnS, the metals Au, Ag, Cu, Al, W, Ta, Ti, Co, Mo, Pt, Ru and Mg and the conductive oxidic materials ITO, IGO, IGZO, AZO and FTO.

~~12~~11. A switching element comprising a molecular layer sandwiched between a first electrode and a second electrode, obtainable by the process according to claim ~~10~~ 9 or ~~11~~10.

~~13~~12. The switching element according to claim ~~12~~11, wherein the molecular layer is a self assembled monolayer.

~~14~~13. Memristive device comprising a switching element according to claim ~~12~~ 11 or ~~13~~12.