Contents

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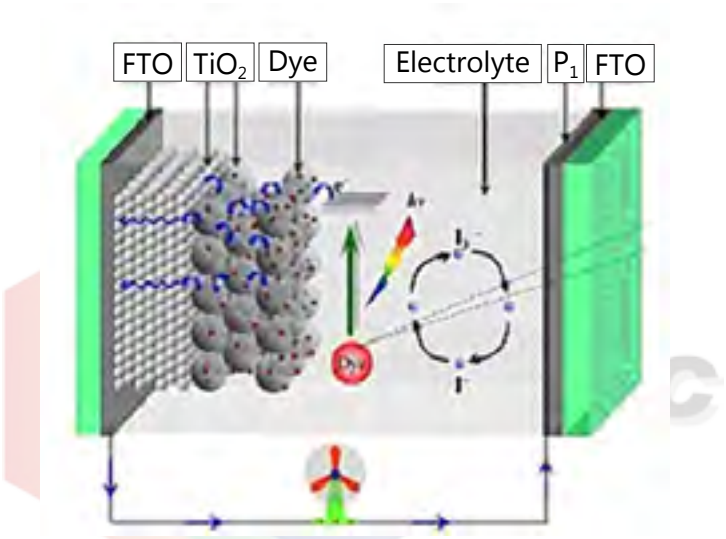
Dye –sensitized solar cell (DSSC) is one of the alternatives for global energy in recent years. It has attracted much attention for the next-generation photovoltaic (PV) devices over conventional silicon based solar cells. Basically the components of DSSC device consist of a porous layer of titanium dioxide nano-particles covered by a molecular dye, a redox couple, and a metal-based (Pt) counter electrode. Among all these components, the redox couple is the critical factor to achieve high efficiency and durability.



Device structure of Dye –Sensitized Solar Cells

Recently, the power conversion efficiency (PCE) has risen up to 13% by using cobalt redox couple[1]. In DSSC, the redox electrolyte is not only produced by the oxidized sensitizer but also acts as an electrically conducting medium. Electrolytes have three groups: liquid electrolyte, quasi-solid electrolyte and solid electrolyte. Liquid electrolyte is commonly used in the most of DSSCs. The redox couple is the key component in a liquid electrolyte and it has some vital requirements[2]:

1. *The redox potential should be less negative than the oxidized level of a dye molecule.*
2. *Slow electron recombination kinetics as the interface.*
3. *Slight visible-light absorption.*
4. *Fast electron-transfer (ET) kinetics at counter electrode.*
5. *Good photochemical stability.*

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The $I^-/I3^-$ is a typically redox couple in DSSCs device for many years. But it has certain constraints. Comparing to the sensitizer oxidation potential (E_0= ~1.0V vs NHE), The $I^-/I3^-$ oxidation potential (E_0= 0.35V vs NHE) has large difference. Additional drawbacks of the $I^-/I3^-$ redox couple are the absorption of tri-iodide up to 430 nm and the volatile of iodine, so the alternative redox couples also have been studied for DSSCs. The transition-metal-based redox is also investigated, including ferrocene/ferrocenium, copper(I/II), cobalt(I/II), nickel(III/IV) complexes..

1. *S. Mathew, A. Yella, P. Gao, R. Humphry-Baker, B. F. E. Curchod, N. Ashari-Astani, I. Tavernelli, U. Rothlisberger, M. K. Nazeeruddin, M. Grätzel, Nat. Chem. 2014, 6, 242-247.*
2. *Lingamallu Giribabu, Ramababu Bolligarla, Mallika Panigrahi, Chem. Rec. 2015, 15, 4, 760-788.*

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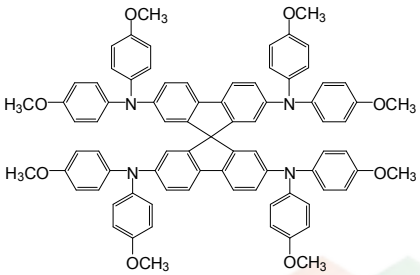
LT-S922 Spiro-MeOTAD

2,2',7,7'-Tetrakis(*N*,*N*-di-*p*-methoxyphenylamino)-9,9'-spirobifluorene

CAS No. : 207739-72-8
Grade : > 99.5% (HPLC)
Formula : $C_{81}H_{68}N_4O_8$
M.W. : 1225.43 g/mole
UV : 306, 385 nm (in CH_2Cl_2)
PL : 429 nm (in CH_2Cl_2)
TGA : > 360 °C (0.5% weight loss)

Reference : 1.MRS. BULLETIN, 30, 2005, p23
2.Appl. Phys. Lett. 100, 173512 (2012)

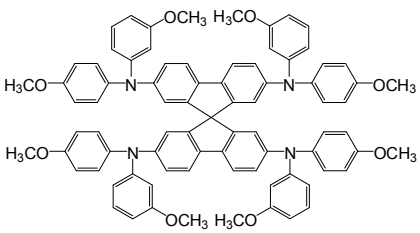


LT-S9145 p,m-Spiro-MeOTAD

N^2,*N*$^{2'}$,*N*^{7},*N*$^{7'}$-Tetrakis(3-methoxyphenyl)-*N*^{2},*N*$^{2'}$,*N*^{7},*N*$^{7'}$-tetrakis(4-methoxyphenyl)-9,9'-spirobi[fluorene]-2,2',7,7'-tetraamine

CAS No. : 1573202-44-4
Grade : > 99% (HPLC)
Formula : $C_{81}H_{68}N_4O_8$
M.W. : 1225.43 g/mole
UV : 308, 378 nm (in CH_2Cl_2)
PL : 414 nm (in CH_2Cl_2)
TGA : > 280 °C (0.5% weight loss)

Reference : J. Am. Chem. Soc. 2014, 136, 7837-7840

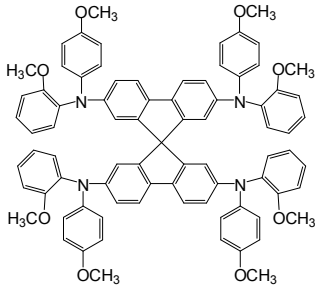


LT-S9146 p,o-Spiro-MeOTAD

N^2,*N*$^{2'}$,*N*^{7},*N*$^{7'}$-Tetrakis(2-methoxyphenyl)-*N*^{2},*N*$^{2'}$,*N*^{7},*N*$^{7'}$-tetrakis(4-methoxyphenyl)-9,9'-spirobi[fluorene]-2,2',7,7'-tetraamine

CAS No. : 1628961-22-7
Grade : > 98.5% (HPLC)
Formula : $C_{81}H_{68}N_4O_8$
M.W. : 1225.43 g/mole
UV : 316, 375 nm (in CH_2Cl_2)
PL : 418 nm (in CH_2Cl_2)
TGA : > 280 °C (0.5% weight loss)

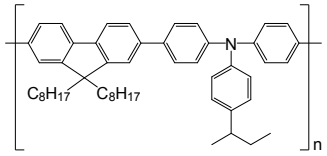
Reference : J. Am. Chem. Soc. 2014, 136, 7837-7840



LT-N148 TFB

Poly[(9,9-dioctylfluorenyl-2,7-diyl)-*co*-(4,4'-(*N*-(4-*sec*-butylphenyl)diphenylamine)]

CAS No. : 220797-16-0
Grade : M_W > 30,000 (GPC)
Formula : $(C_{51}H_{61}N)_n$
UV : 389 nm (in CH_2Cl_2)
PL : 443 nm (in CH_2Cl_2)
Solubility : Soluble in CH_2Cl_2,Toluene, $CHCl_3$

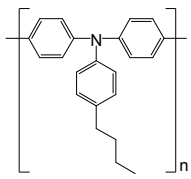


LT-N149 Poly-TPD

Poly[*N*,*N*'-bis(4-butylphenyl)-*N*,*N*'-bis(phenyl)-benzidine]

CAS No. : 472960-35-3
Grade : M_W > 10,000 (GPC)
Formula : $(C_{22}H_{21}N)_n$
UV : 371, 388 nm (in CH_2Cl_2)
PL : 424 nm (in CH_2Cl_2)
Solubility : Soluble in $CHCl_3$, Chlorobenzene

Reference : Nature Photonics 8, 128-132 (2014)



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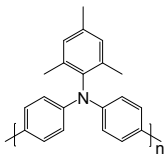
LT-N168 PTAA

Poly[bis(4-phenyl)(2,4,6-trimethylphenyl)amine]

CAS No. : 1333317-99-9
Grade : M_W > 10,000 (GPC)
Formula : $(C_{21}H_{19}N)_n$
UV : 371, 388 nm (in CH_2Cl_2)
PL : 424 nm (in CH_2Cl_2)
Solubility : Soluble in $CHCl_3$, Chlorobenzene, Dichlorobenzene

Reference : Nature Photonics 7, 486-491 (2013)

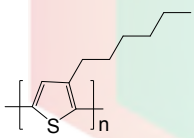


LT-S909 P3HT

Poly(3-hexylthiophene-2,5-diyl)

CAS No. : 156074-98-5
Grade : M_W > 45,000 (GPC)
Formula : $(C_{10}H_{14}S)_n$
UV : 445 nm (in THF)
PL : 564 nm (in THF)
Solubility : Soluble in $CHCl_3$, Chlorobenzene, Dichlorobenzene

Reference : Journal of Power Sources, 251, (2014), 152-156



LT-PS001 PEDOT:PSS

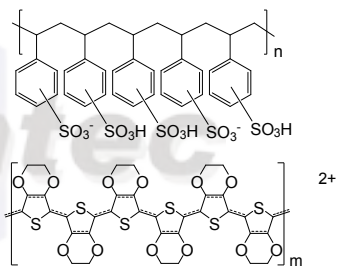
Poly(3,4-ethylenedioxythiophene)-poly(styrenesulfonate)

Specification

Description : Aqueous dispersion, blue liquid.
Sodium : Max. 400 ppm
Sulfate : Max. 40 ppm
Solid content : 1.3 - 1.7 wt%
PSD d_{50} : 80 nm
PSD d_{90} : 100 nm
Resistivity : 500-5000 Ωcm
Viscosity : 5-12 mPas

Technical Data (guide values, not a specification)

Form : liquid
Odour : odourless
Colour : dark blue
PEDOT:PSS ratio : 1:6 (by weight)
PEDOT work function : approx 5.2 eV
pH : 1.2 - 2.2 at 20°C
Boiling Point : approx 100°C
Storage : The product is sensitive to frost and should therefore not be stored at temperatures below 5°C.
Avoid freezing!



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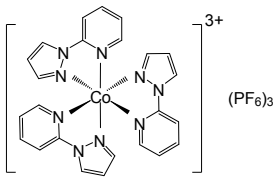
LT-S9135 FK102 Co(III) PF_6_Salt

Tris(1-(pyridin-2-yl)-1*H*-pyrazol)cobalt(III) tris (hexafluorophosphate)

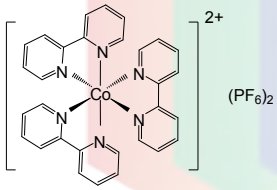
CAS No. : 1346416-70-3
Grade : > 99% (NMR)
Formula : $C_{24}H_{21}CoF_{18}N_9P_3$
M.W. : 1169.43 g/mol
$E^0_{2+/3+}$: 0.96 V vs NHE
Reference : J. Am. Chem. Soc., 2011, 133, 18042-18045



LT-S9183 Co(II)$(bpy)_3(PF_6)_2$

Tris-(2,2'-bipyridine)cobalt(II) bis(hexafluorophosphate)

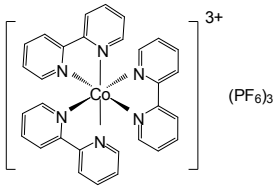
CAS No. : 79151-78-3
Grade : > 99% (NMR)
Formula : $C_{30}H_{24}CoF_{12}N_6P_2$
M.W. : 817.41 g/mol
$E^0_{2+/3+}$: 0.56 V vs NHE
Reference : J. Am. Chem. Soc., 2010, 132, 16714



LT-S9184 Co(III) $(bpy)_3(PF_6)_3$

Tris-(2,2'-bipyridine)cobalt(III) tris(hexafluorophosphate)

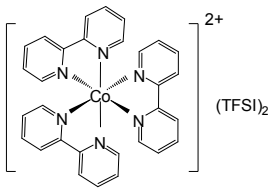
CAS No. : 28277-53-4
Grade : > 99% (NMR)
Formula : $C_{30}H_{24}CoF_{18}N_6P_3$
M.W. : 962.38 g/mol
$E^0_{2+/3+}$: 0.56 V vs NHE
Reference : Chem. Mater., 2013, 25 (13), pp 2733-2739



LT-S9185 Co(II)$(bpy)_3(TFSI)_2$

Tris-(2,2'-bipyridine)cobalt(II) bis(trifluoromethanesulfonim ide)

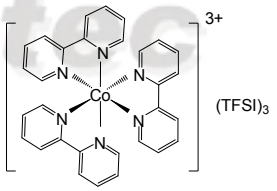
CAS No. : 1353745-90-0
Grade : > 99% (NMR)
Formula : $C_{34}H_{24}CoF_{12}N_8O_8S_4$
M.W. : 1087.78 g/mol
$E^0_{2+/3+}$: 0.57 V vs NHE
Reference : Chem. Mater., 2013, 25 (13), pp 2733-2739



LT-S9186 Co(III)$(bpy)_3(TFSI)_3$

Tris-(2,2'-bipyridine)cobalt(III) tris(trifluoromethanesulfoni mide)

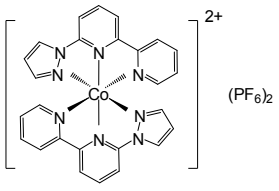
CAS No. : 1353745-91-1
Grade : > 99% (NMR)
Formula : $C_{36}H_{24}CoF_{18}N_9O_{12}S_6$
M.W. : 1367.92 g/mol
$E^0_{2+/3+}$: 0.57 V vs NHE
Reference : Chem. Mater., 2013, 25 (13), pp 2733-2739



LT-S9187 Co(II)$(bpy\text{-}pz)_2(PF_6)_2$

Bis(6-(1H -pyrazol-1-yl)-2,2'-bipyridine)cobalt(II) bis(hexafluorophosphate), mixture of stereoisomers

CAS No. : 312322-08-0
Grade : > 99% (NMR)
Formula : $C_{26}H_{20}CoF_{12}N_8P_2$
M.W. : 793.35 g/mol
$E^0_{2+/3+}$: 0.86 V vs NHE
Reference : 1. Phys. Chem. Chem. Phys., 2013, 15, 7087-7097
2. Nat. Commun. 3:631



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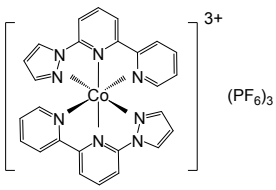
LT-S9188 Co(III)(bpy-pz)$_2$(PF$_6$)$_3$

Bis(6-(1H -pyrazol-1-yl)-2,2'-bipyridine)cobalt(III) tris(hexafluorophosphate) , mixture of stereoisomers

CAS No. : 1346417-60-4
Grade : > 99% (NMR)
Formula : $C_{26}H_{20}CoF_{18}N_8P_3$
M.W. : 938.32 g/mol
$E^0_{2+/3+}$: 0.86 V vs NHE

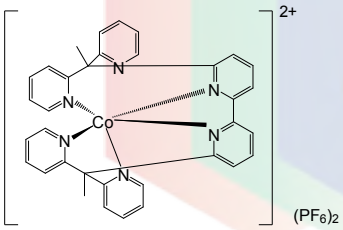
Reference : 1. Phys. Chem. Chem. Phys., 2013, 15, 7087-7097
2. Nat. Commun. 3:631



LT-S9189 Co(II)(bpyPY4)$_3$(PF$_6$)$_2$

[6,6'-bis(1,1-di(pyridin-2-yl)ethyl)-2,2'-bipyridine]cobalt(II) bis(hexafluorophosphate)

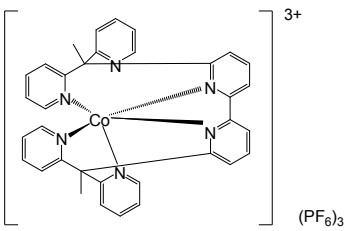
Grade : > 99% (NMR)
Formula : $C_{34}H_{30}CoF_{12}N_6P_2$
M.W. : 869.49 g/mol
$E^0_{2+/3+}$: 0.46 V vs NHE



LT-S9190 Co(II)(bpyPY4)$_3$(PF$_6$)$_3$

[6,6'-bis(1,1-di(pyridin-2-yl)ethyl)-2,2'-bipyridine]cobalt(II) tris(hexafluorophosphate)

Grade : > 99% (NMR)
Formula : $C_{34}H_{30}CoF_{18}N_6P_3$
M.W. : 1014.45 g/mol
$E^0_{2+/3+}$: 0.46 V vs NHE

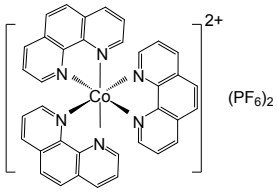


LT-S9191 Co(II)(phen)$_3$(PF$_6$)$_2$

Tris(1,10-phenanthroline)cobalt(II) bis(hexafluorophosphate)

CAS No. : 31876-74-1
Grade : > 99% (NMR)
Formula : $C_{36}H_{24}CoF_{12}N_6P_2$
M.W. : 889.48 g/mol
$E^0_{2+/3+}$: 0.61 V vs NHE

Reference : Phys. Chem. Chem. Phys., 2013, 15, 7087-7097

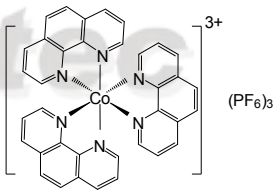


LT-S9192 Co(III)(phen)$_3$(PF$_6$)$_3$

Tris(1,10-phenanthroline)cobalt(III) tris (hexafluorophosphate)

CAS No. : 28277-59-0
Grade : > 99% (NMR)
Formula : $C_{36}H_{24}CoF_{18}N_6P_3$
M.W. : 1034.44 g/mol
$E^0_{2+/3+}$: 0.61 V vs NHE

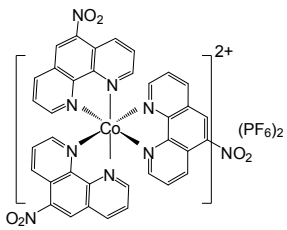
Reference : Phys. Chem. Chem. Phys., 2013, 15, 7087-7097



LT-S9193 Co(II)(NO$_2$-phen)$_3$(PF$_6$)$_2$

Tris(5-nitro-1,10-phenanthroline)cobalt(II) bis (hexafluorophosphate)

Grade : > 99% (NMR)
Formula : $C_{36}H_{21}CoF_{12}N_9O_6P_2$
M.W. : 1024.47 g/mol
$E^0_{2+/3+}$: 0.85 V vs NHE



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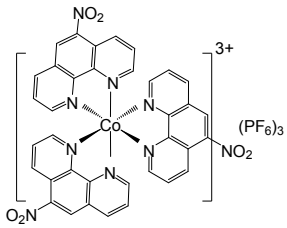
LT-S9194 Co(III)(NO2-phen)$_3$(PF_6)$_3$

Tris(5-nitro-1,10-phenanthroline)cobalt(III) tris (hexafluorophosphate)

Grade : > 99% (NMR)
Formula : $C_{36}H_{21}CoF_{18}N_9O_6P_3$
M.W. : 1169.43 g/mol
$E^0_{2+/3+}$: 0.85 V vs NHE

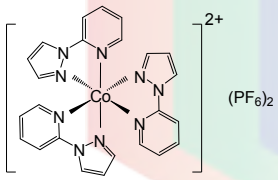


LT-S9195 FK102 Co(II) PF_6Salt

Tris(1-(pyridin-2-yl)-1H-pyrazol)cobalt(II) bis (hexafluorophosphate)

CAS No. : 1392221-69-0
Grade : > 99% (NMR)
Formula : $C_{24}H_{21}CoF_{12}N_9P_2$
M.W. : 784.35 g/mol
$E^0_{2+/3+}$: 0.96 V vs NHE

Reference : J. Am. Chem. Soc., 2011, 133, 18042-18045



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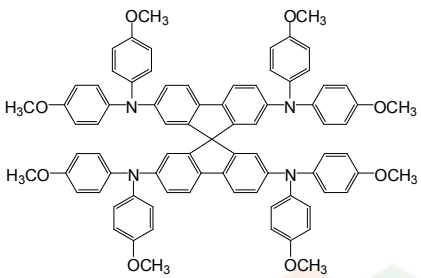
LT-S922 Spiro-MeOTAD

2,2',7,7'-Tetrakis(*N*,*N*-di-*p*-methoxyphenylamino)-9,9'-spirobifluorene

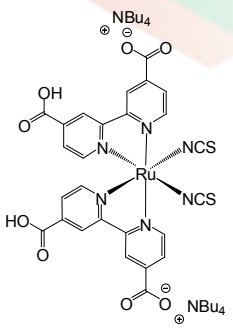
CAS No. : 207739-72-8
Grade : > 99.5% (HPLC)
Formula : $C_{81}H_{68}N_4O_8$
M.W. : 1225.43 g/mole
UV : 306, 385 nm (in CH_2Cl_2)
PL : 429 nm (in CH_2Cl_2)
TGA : > 360 °C (0.5% weight loss)
Reference : 1.MRS. BULLETIN, 30, 2005, p23
2.Appl. Phys. Lett. 100, 173512 (2012)



LT-S945 N719

Di-tetrabutylammonium *cis*-bis(isothiocyanato)bis(2,2'-bipyridyl-4,4'-dicarboxylato)ruthenium(II)

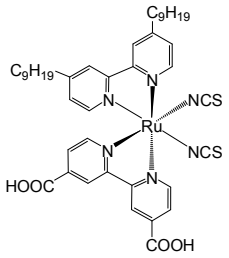
CAS No. : 207347-46-4
Grade : > 98% (HPLC)
Formula : $C_{58}H_{86}N_8O_8RuS_2$
M.W. : 1188.55 g/mole
UV : 313, 534 nm (in EtOH)
Reference : Inorg. Chem. 1999, 38, 6298-6305



LT-S964 Z-907

cis-Bis(isothiocyanato)(2,2'-bipyridyl-4,4'-dicarboxylato)(4,4'-di-nonyl-2'-bipyridyl)ruthenium(II)

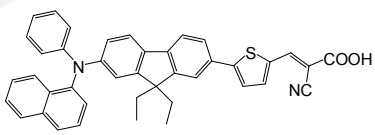
CAS No. : 502693-09-6
Grade : > 98% (HPLC)
Formula : $C_{42}H_{52}N_6O_4RuS_2$
M.W. : 870.10 g/mole
UV : 295, 531 nm (in EtOH)
Reference : Nature Materials 2, 402-407 (2003)



LT-S9023 DEFL-NPB-TCA

(*E*)-3-(5-(2-(*N*-(naphthalen-5-yl)-*N*-phenylamino)-9,9-diethyl-9*H*-fluoren-7-yl)thiophen-2-yl)-2-cyanoacrylic acid

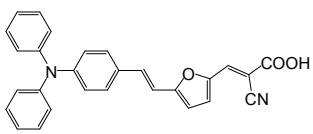
CAS No. : 1234799-59-7
Grade : > 99% (NMR)
Formula : $C_{41}H_{32}N_2O_2S$
M.W. : 616.10 g/mole
UV : 421 nm (in THF)
PL : 538 nm (in THF)
TGA : > 250 °C (0.5% weight loss)
Reference : Chem. Commun.,2005, 4098-4010



LT-S9024 DPAS-FCA

(*E*)-2-cyano-3-(5-(4-(diphenylamino)styryl)furan-2-yl) acrylic acid

CAS No. : 1096712-02-5
Grade : > 99% (NMR)
Formula : $C_{28}H_{20}N_2O_3$
M.W. : 432.10 g/mole
UV : 469 nm (in THF)
PL : 533 nm (in THF)
TGA : > 250 °C (0.5% weight loss)
Reference : Org. Lett. 2009, 11, 97



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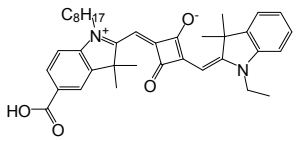
LT-S9037 SQ01

(*E*)-4-((5-carboxy-3,3-dimethyl-1-octyl-3*H*-indolium-2-yl)methylene)-2-((*E*)-(1-ethyl-3,3-dimethylindolin-2-ylidene)methyl)-3-oxocyclobut-1-enolate

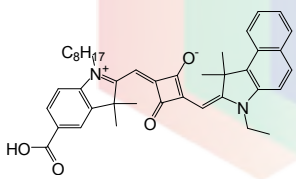
CAS No. : 951248-19-4
Grade : > 99% (HPLC)
Formula : $C_{37}H_{44}N_2O_4$
M.W. : 580.67 g/mole
UV : 637 nm (in DMF)
TGA : > 220 °C (0.5% weight loss)
Reference : Adv. Funct. Mater. 2009, 19, 2720-2727



LT-S9038 SQ02

(*E*)-4-((5-carboxy-3,3-dimethyl-1-octyl-3*H*-indolium-2-yl)methylene)-2-((*E*)-(3-ethyl-1,1-dimethyl-1*H*-benzo[*e*]indol-2(3*H*)-ylidene)methyl)-3-oxocyclobut-1-enolate

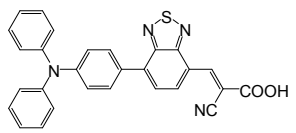
CAS No. : 1240041-84-2
Grade : > 99% (HPLC)
Formula : $C_{41}H_{46}N_2O_4$
M.W. : 630.81 g/mole
UV : 662 nm (in DMF)
TGA : > 250 °C (0.5% weight loss)
Reference : Adv. Funct. Mater. 2009, 19, 2720-2727



LT-S9068 RL-1

2-Cyano-3-(7-(4-(diphenylamino)phenyl)-benzo[*c*][1,2,5]thiadiazol-4-yl)acrylic acid

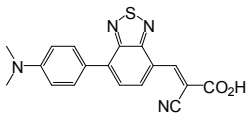
CAS No. : 1415134-59-6
Grade : > 99% (NMR)
Formula : $C_{28}H_{18}N_4O_2S$
UV : 324, 486 nm (in THF)
TGA : > 240 °C (0.5% weight loss)
Reference : Chem. Commun. 2012, 48, 12071-12073



LT-S9121 CDMA-PBTCA

2-Cyano-3-(7-(4-(dimethylamino)phenyl)-benzo[*c*][1,2,5]-thiadiazol-4-yl)acrylic acid

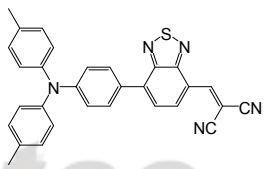
Grade : > 99% (NMR)
Formula : $C_{18}H_{14}N_4O_2S$
M.W. : 350.39 g/mole



LT-S9122 DTDCPB

2-((7-(4-(dip-tolylamino)phenyl)benzo[*c*] [1,2,5] thiadiazol-4-yl)methylene)malononitrile

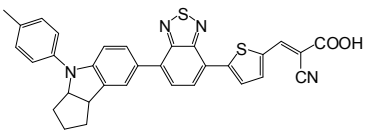
CAS No. : 1393343-58-2
Grade : > 99% (NMR)
Formula : $C_{30}H_{21}N_5S$
M.W. : 483.59 g/mole
UV : 306, 568 nm (in CH_2Cl_2)
Reference : ACS Nano, 2014, 8 (2), pp 1674-1680



LT-S9166 WS-2

(*E*)-2-cyano-3-(5-(7-(4-(p-tolyl)-1,2,3,3a,4,8b-hexahydrocyclopenta[b]indol-7-yl)benzo[c][1,2,5]thiadiazol-4-yl)thiophen-2-yl)acrylic acid

CAS No. : 1263863-11-1
Grade : > 99% (HPLC)
Formula : $C_{32}H_{24}N_4O_2S_2$
M.W. : 560.6900 g/mole
UV : 546 nm (in CH_2Cl_2)
Reference : 1.MRS. BULLETIN, 30, 2005, p23
2.Appl. Phys. Lett. 100, 173512 (2012)



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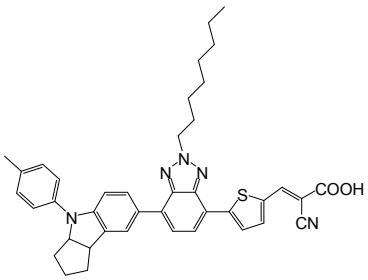
LT-S9167 WS-5

(*E*)-2-cyano-3-(5-(2-octyl-7-(4-(p-tolyl)-1,2,3,3a,4,8*b*-hexahydrocyclopenta[b]indol-7-yl)-2*H*-benzo[*d*][1,2,3]triazol-4-yl)thiophen-2-yl)acrylic acid

CAS No. : 1334739-85-3
Grade : > 99% (HPLC)
Formula : $C_{40}H_{41}N_5O_2S$
M.W. : 655.8610 g/mole
UV : 496 nm (in CH_2Cl_2)

Reference : Chem. Mater. 2011, 23, 4394; ACS Appl. Mater. Interfaces 2014, 6, 14621

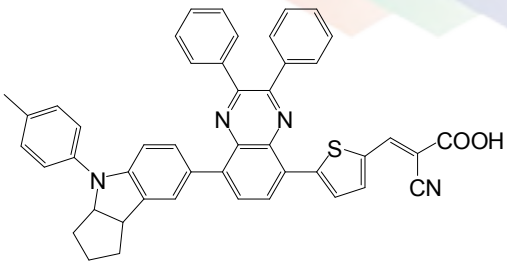


LT-S9168 IQ-4

(*E*)-2-cyano-3-(5-(2,3-diphenyl-8-(4-(*p*-tolyl)-1,2,3,3*a*,4,8*b*-hexahydrocyclopenta[b]indol-7-yl)quinoxalin-5-yl)thiophen-2-yl)acrylic acid

CAS No. : 1440205-23-1
Grade : > 99% (HPLC)
Formula : $C_{46}H_{34}N_4O_2S$
M.W. : 706.8640 g/mole
UV : 529 nm (in CH_2Cl_2)

Reference : ACS Appl. Mater. Interfaces 2013, 5, 4986; J. Am. Chem. Soc. 2014, 136, 5722.



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