

Organic Semiconductors for Advanced Electronics

Vol. 4 No. 8

Conducting Polymers

Light Emitting Polymers

Charge Transport
Materials

Semiconducting Small
Molecules

Light Emitting Metal
Complexes

Spin Coating Equipment

Anode Substrates

Reference Materials

Introduction

The field of organic electronics is an active emerging technology with immense promise for innovative, convenient and high-performance electronics. Breakthrough products employed in commercial technologies include organic light-emitting diodes (OLEDs) used in displays for car radios.¹ Organic field effect-transistors (OFETs) are showing promise as their efficiencies are being rapidly improved.² Organic photovoltaics and fuel cells also employ conducting polymers for a number of applications.³ Two classes of materials are actively investigated for organic electronic applications:

Electronic Polymers: These materials contain an extended π -conjugated organic backbone, giving rise to their unique opto-electrical properties. The inherently (or intrinsically) conductive polymers (ICPs) possess the electrical properties of metals or semiconductors while exhibiting the mechanical properties and processing characteristics of polymers. Applications for ICPs include, electromagnetic-interference (EMI) shielding, conductive layers for OLEDs and OFETs, optically active layers for OLEDs, and anti-corrosion coatings for iron and steel. ICPs include polythiophene, PANI, and PPy. The light emitting polymers (LEPs) possess electronic bandgaps that allow for the emission of visible light. These polymers include PPV, CN-PPV, PFO, and PFE.

Semiconducting Oligomers: Small organic or organometallic molecules possessing extended π -conjugation that can form well-ordered crystalline films. These materials may be processed by either solution or thermal deposition techniques and include products like anthracene, rubrene, Alq₃, and sexithiophene.

Sigma-Aldrich, a leader in High Technology products, offers a broad portfolio of organic semiconductor materials for your research and development needs. In addition to a wide range of polymers and oligomers, we offer a complement of monomer precursors enabling you to develop your own new materials. If you can not find a product as needed, please contact your local Sigma-Aldrich office (see back cover).

Product Locator

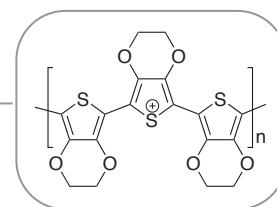
Properties	Products	Abbreviations	Processing Method		Page
			Vacuum	Solution	
Electroluminescent Materials	Aluminum hydroxyquinoline	Alq ₃	X	X	11
	Bathocuproine	BCP		X	11
	Cyano polyphenylene vinylenes	CN-PPV		X	6
	Europium Triplets Emitters	–	X	X	11
	Polyfluorenes	PFO		X	8
	Polyfluoreneethynyls	PFE		X	8
	Polyphenylene vinylenes	PPV		X	7
	Rubrenes	–	X	X	9
Electron Transport	Aluminum hydroxyquinoline	Alq ₃	X	X	11
	Other metal quinolines	Zrq ₂ , Bq ₄	X	X	11
Hole Blocking	N,N'-Dimethyl-quinacridone	DMQA		X	11
Hole Injection	Copper phthalocyanine	CuPc	X	X	11
	Poly(3,4-ethylenedioxythiophene)	PEDOT/PSS		X	1
	Polyanilines	PANI		X	3
	Sexithiophenes	6T, DH-6T	X	X	2
	Tetracyano materials	TCNE, TCQF	X	X	10
Hole Transport	Polyarylamines	TPD, NPD		X	9
	Polyphenylene vinylenes	PPV		X	7
	Polyvinylnaphthalene	PVN		X	9
	Titanium phthalocyanine	TiPc	X		9
Inherently Conductive Polymers (ICP)	Poly(3,4-ethylenedioxythiophene)	PEDOT/PSS		X	1
	Polyanilines	PANI		X	3
	Polypyrroles	PPy		X	4
	Polythioacetylenes	PA		X	5
	Polythiophenes	P3AT		X	1
Semiconducting Oligomers	Oligothiophenes	3T, 6T, DH-6T	X	X	2
	Other Small Molecule Organics	–	X	X	9
	Pentacene	–	X	X	9

Contact your local Sigma-Aldrich office to request absorption and spectra of any light emitting material in this brochure.

Conducting Polymers

PEDOT

Poly(2,3-dihydrothieno-1,4-dioxin) combines optical transparency in the visible spectrum, good electrical conductivity and stability. PEDOT/PSS is the most widely used hole injecting material in OLEDs.⁴ Sigma-Aldrich offers several grades of processable PEDOT. The EDOT monomer is available for your synthesis needs.



Cat #	Product Name	Size	Structure
48,309-5	PEDOT/PSS 1.3 wt% in water poly(styrenesulfonate) doped	250 g	 -[PEDOT] _n -
56,059-6	electronic grade, 2.8 wt% in water poly(styrenesulfonate) doped	25 g 100 g	
64,978-3	PEDOT-block-PEG 1 wt% dispersion in propylene carbonate perchlorate doped	25 g	 R=Proprietary linker
64,979-1	1 wt% dispersion in nitromethane p-toluenesulfonate doped	25 g	
64,980-5	1 wt% dispersion in nitromethane perchlorate doped	25 g	
64,981-3	PEDOT tetramethacrylate end-capped 0.5 wt% in propylene carbonate p-toluenesulfonate doped	25 g	 R=Proprietary linker
64,982-1	0.5 wt% in nitromethane p-toluenesulfonate doped	25 g	
48,302-8	2,3-Dihydrothieno(3,4-b)-1,4-dioxin (EDOT) CAS#: 126213-50-1 MW: 142.18 g/mol	10 g	

Polythiophenes

Some of the most extensively studied π -conjugated polymers, are the conducting and semiconducting poly-3-alkylthiophenes (P3AT) which are very stable and readily characterized. The mono-, di- and ring substituted polythiophenes exhibit good solubility and tunable band gaps. Applications include, OLEDs, OFETs and other molecular electronic devices.⁵ Sigma-Aldrich offers highly regiocontrolled polyalkylthiophenes (>98.5% head-to-tail), which exhibit high charge mobilities, as well as regiorandom analogs.

Cat #	Product Names	R	Type	Size	Structure
44,570-3	Poly(3-hexylthiophene-2,5-diyl)	-C ₆ H ₁₃	Regioregular	1 g	 Regioregular
44,571-1	Poly(3-octylthiophene-2,5-diyl)	-C ₈ H ₁₇	Regioregular	1 g	
45,065-0	Poly(3-dodecylthiophene-2,5-diyl)	-C ₁₂ H ₂₅	Regioregular	1 g	
49,533-6	Poly(3-butylthiophene-2,5-diyl)	-C ₄ H ₉	Regioregular	1 g	
49,534-4	Poly(3-decylthiophene-2,5-diyl)	-C ₁₀ H ₂₁	Regioregular	1 g	
65,004-8	Poly(3-(2-methoxyethoxy)-ethoxymethylthiophene-2,5-diyl)	-	Regioregular	1 g	
65,005-6	Poly(3-(2-methoxyethoxy)-ethoxythiophene-2,5-diyl)	-	Regioregular	1 g	 Regiorandom If R ₁ = R then R ₂ = H If R ₂ = R then R ₁ = H
51,082-3	Poly(3-hexylthiophene-2,5-diyl)	-C ₆ H ₁₃	Regiorandom	1 g	
51,083-1	Poly(3-octylthiophene-2,5-diyl)	-C ₈ H ₁₇	Regiorandom	1 g	
51,085-8	Poly(3-decylthiophene-2,5-diyl)	-C ₁₀ H ₂₁	Regiorandom	1 g	
51,086-6	Poly(3-dodecylthiophene-2,5-diyl)	-C ₁₂ H ₂₅	Regiorandom	1 g	
51,142-0	Poly(3-butylthiophene-2,5-diyl)	-C ₄ H ₉	Regiorandom	1 g	
52,593-6	Poly(thiophene-2,5-diyl)	-	Br Terminated	1 g	
55,762-5	Poly(3-cyclohexylthiophene-2,5-diyl)	-	-	1 g	
55,763-3	Poly(3-cyclohexyl-4-methylthiophene-2,5-diyl)	-	-	1 g	

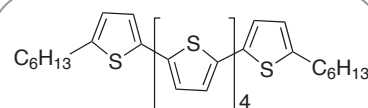


To discuss how our expertise can benefit your next scale-up project or to obtain a quote, contact your local Sigma-Aldrich office or visit www.safglobal.com

For technical assistance or to order: please call your local Sigma-Aldrich office

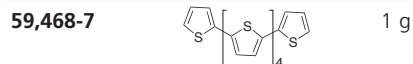
Oligothiophenes

Oligothiophenes are generating interest in conductive polymer research for their high charge mobilities and on/off ratios as *p*-type semiconductors.⁶ Garnier et al. fabricated the first all-organic transistor based on α -sexithiophene (6T). Substitution of the α and ω -positions on sexithiophene with alkyl chains increases the charge carrier mobility and improves the solubility in organic solvents, making DH-6T easier to process.



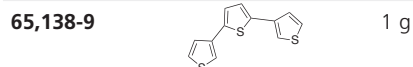
63,321-6
 α,ω -Dihexylsexithiophene (DH-6T)
500 mg

α -Sexithiophene (6T)



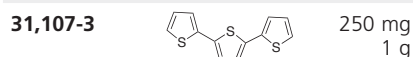
CAS NO: 88493-55-4
MF: C₂₄H₁₈S₆
FW: 494.76
mp: 290 °C (dec.)

3,2':5',3"-Terthiophene



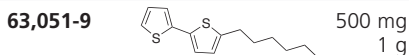
CAS NO: 81294-16-8
MF: C₁₇H₈S₃
MW: 248.39

2,2':5',2"-Terthiophene, 99%



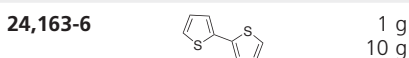
CAS NO: 1081-34-1
MF: C₁₇H₈S₃
FW: 248.39
mp: 93-95 °C

5-Hexyl-2,2'-bithiophene, 97%



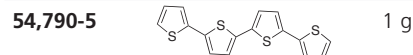
CAS NO: 173448-31-2
MF: C₁₄H₁₈S₂
FW: 250.42
bp: 355 °C (760 mmHg)

2,2'-Bithiophene, 97%



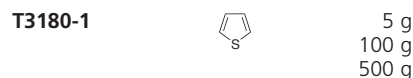
CAS NO: 492-97-7
MF: C₈H₆S₂
FW: 166.26
mp: 32-33 °C

2,2':5',2'':5',2'''-Quaterthiophene, 96%



CAS NO: 5632-29-1
MF: C₁₆H₁₀S₄
FW: 330.49
mp: 211-214 °C

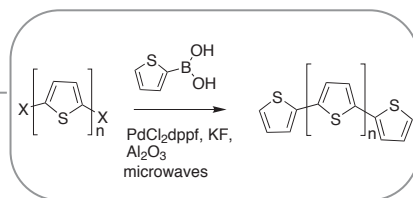
Thiophene, 99%



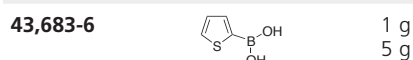
CAS NO: 110-02-1
MF: C₄H₄S
FW: 84.14
bp: 84 °C (760 mmHg)

Monomers for Polythiophene Synthesis

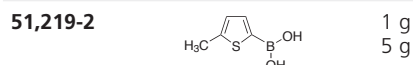
Barbarella and co-workers recently demonstrated rapid microwave assisted synthesis of oligothiophenes via a Suzuki coupling route.⁷ Sigma-Aldrich offers a complete line of thioboronic acids* and halogenated thiophenes for this application. We carry functionalized thiophenes for your tailored materials.



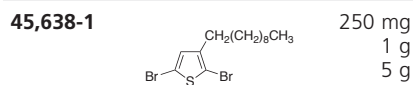
2-Thiopheneboronic acid



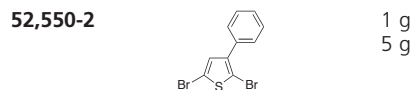
5-Methyl-2-thiopheneboronic acid



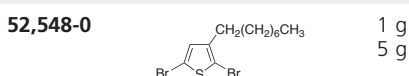
2,5-Dibromo-3-decylthiophene, 96%



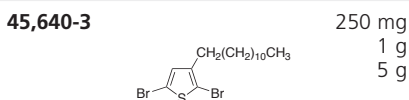
2,5-Dibromo-3-phenylthiophene, 97%



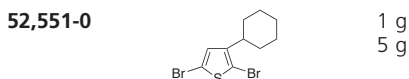
2,5-Dibromo-3-octylthiophene, 96%



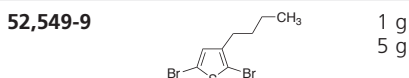
2,5-Dibromo-3-dodecylthiophene, 97%



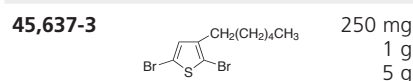
2,5-Dibromo-3-cyclohexylthiophene, 97%



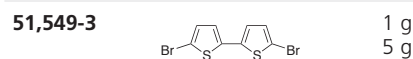
2,5-Dibromo-3-butylthiophene, 96%



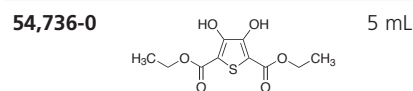
2,5-Dibromo-3-hexylthiophene, 97%



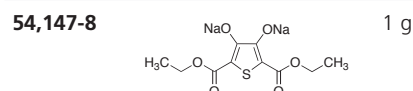
5,5'-Dibromo-2,2'-bithiophene, 99%



3,4-Dihydroxy-thiophene-2,5 dicarboxylic acid diethyl ester



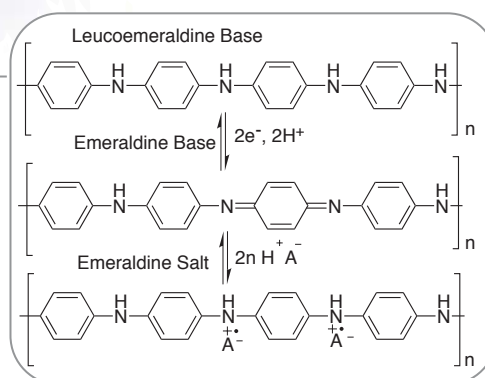
3,4-Dihydroxy-thiophene-2,5 dicarboxylic acid diethyl ester, disodium salt



*For additional thioboronic acids for Suzuki coupling, see Chemfile Vol. 4 No. 3, "Reagents for C-C Bond Formation" (HAS), available from Sigma-Aldrich.

Polyanilines

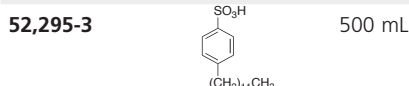
Polyaniline (PANI) is a versatile conducting polymer with a myriad of applications because of its unique physical and chemical properties.⁸ PANI is easily processed by melt or solution processes, and is environmentally and thermally stable. PANI exists in three stable oxidation states (as shown) and a fourth, unstable, fully oxidized form known as pernigraniline. The doped emeraldine salt form of PANIs exhibit very high conductivities. Sigma-Aldrich offers a full line of the stable, doped and undoped PANIs for a variety of processing needs. We also offer high performance dopants for our undoped PANIs.



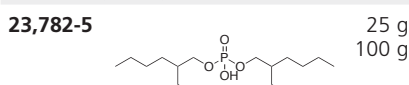
Catalog #	Polyaniline Product	Dopant	Avg. Mw	Conductivity (S/cm)	Size
65,001-3	Emeraldine salt, 2-3 wt. % dispersion in xylene	Organic Sulfonic Acid	-	10-20 (as film)	10 mL 50 mL
64,999-6	Emeraldine salt, 0.5 wt. % dispersion in mixed solvents	Organic Sulfonic Acid	-	~1 (as film)	10 mL 50 mL
42,832-9	Emeraldine salt	Organic Sulfonic Acid	>15,000	2-4	5 g 25 g
53,056-5	Emeraldine salt, composite with carbon black	Organic Sulfonic Acid	-	40	5 g 25 g
57,707-3	Emeraldine salt coated on Nylon	Organic Sulfonic Acid	-	0.2	10 g
56,109-6	Emeraldine salt, ~20% wt in water, short chain grafted to lignin	Ligno-sulfonic acid	-	1-2	10 g 50 g
56,111-8	Emeraldine salt, ~20% wt in water, long chain grafted to lignin	Ligno-sulfonic acid	-	4-6	10 g 50 g
56,112-6	Emeraldine salt, powder, short chain grafted to lignin	Ligno-sulfonic acid	-	1-2	2 g 10 g
56,113-4	Emeraldine salt, powder, long chain grafted to lignin	Ligno-sulfonic acid	-	4-6	2 g 10 g
55,645-9	Emeraldine base	Undoped	5,000	-	5 g 25 g
47,670-6	Emeraldine base	Undoped	10,000	-	10 g 50 g
55,637-8	Emeraldine base	Undoped	20,000	-	5 g 25 g
55,638-6	Emeraldine base	Undoped	50,000	-	5 g 25 g
53,068-9	Emeraldine base	Undoped	65,000	-	10 g 50 g
57,637-9	Emeraldine base	Undoped	100,000	-	5 g 25 g
57,647-6	Emeraldine base	Undoped	300,000	-	5 g 25 g
53,067-0	Leucoemeraldine base	-	-	-	5 g

Polyaniline Dopants

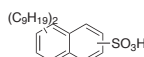
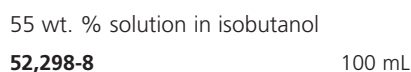
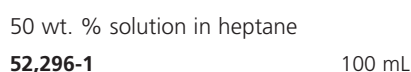
Dodecylbenzenesulfonic acid (DBSA)



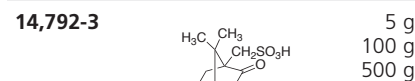
Bis(2-ethylhexyl) phosphate (DEHHP)



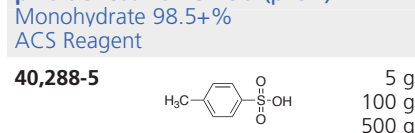
Dinonylnaphthalenesulfonic acid (DNSA)



(±)-Camphor-10-sulfonic acid (β) (CSA)



p-Toluenesulfonic Acid (pTSA)

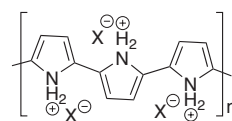


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Polypyrroles (PPy)

PPy exhibits high conductivity and good stability.⁹ PPy films are easily fabricated on a number of surfaces. In the oxidized state, PPy is a radical cation charge balanced by dopant anions. PPy finds applications in batteries, chemical sensors, ion selective electrodes, and conductive coatings for nanomaterials. PPy nanowires have also been fabricated.¹⁰

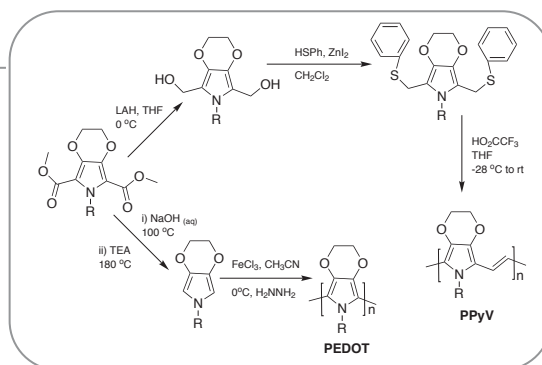


Catalog #	Polypyrrole	Conductivity (S/cm)	Size
57,703-0	Polypyrrole* powder	10-40 pressed pellet	5 g 25 g
48,255-2	Polypyrrole 5 wt. % solution in water	10-40 pressed pellet	100 mL
53,057-3	Polypyrrole* composite 20 wt% loading on carbon black	30 bulk	25 g
57,706-5	Polypyrrole composite, undoped 20 wt% loading on carbon black	13-20 bulk	10 g
57,817-7	Polypyrrole* composite 5 wt% loading on TiO ₂	0.8-1.0 pressed pellet	10 g

*Doped with proprietary organic sulfonic acid

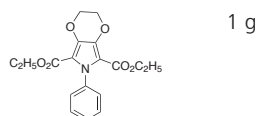
New Polypyrrole Starting Materials

Sigma-Aldrich offers a complete line of monomers for the synthesis of polyethylenedioxyppyrole (PEDOP) and polypropylenedioxyppyrole (PPDOP). Ethylene and propylene substitution of pyrrole serves to enhance the electronic properties of pyrroles and the alkyl substitutions improve processability. Carboxylic ester substituted EDOPs are precursors to both PEDOP and the conducting pyrrolylene vinylenes (PPyV)¹¹ as shown in the reaction schemes. One solution processable PPyV, PDPV (R=dodecyl) has a band gap of 1.67 eV.¹²



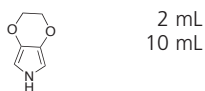
Diethyl 1-benzyl-3,4-ethylenedioxyppyrole-2,5-dicarboxylate, 95%

63,708-4



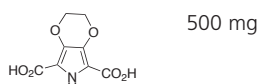
3,4-Ethylenedioxyppyrole, 2% (w/v) solution in THF

64,831-0



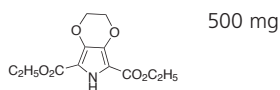
3,4-Ethylenedioxyppyrole-2,5-dicarboxylic acid, 95%

63,720-3



Diethyl-3,4-ethylenedioxyppyrole-2,5-dicarboxylate, 98%

63,716-5



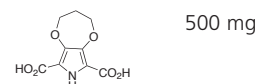
3,4-Propylenedioxyppyrole 2% (w/v) solution in THF

64,832-9



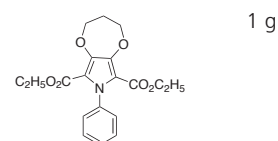
3,4-Propylenedioxyppyrole-2,5-dicarboxylic acid, hydrate, 95%

63,743-2



Diethyl 1-benzyl-3,4-propylenedioxyppyrole-2,5-dicarboxylate

63,741-6

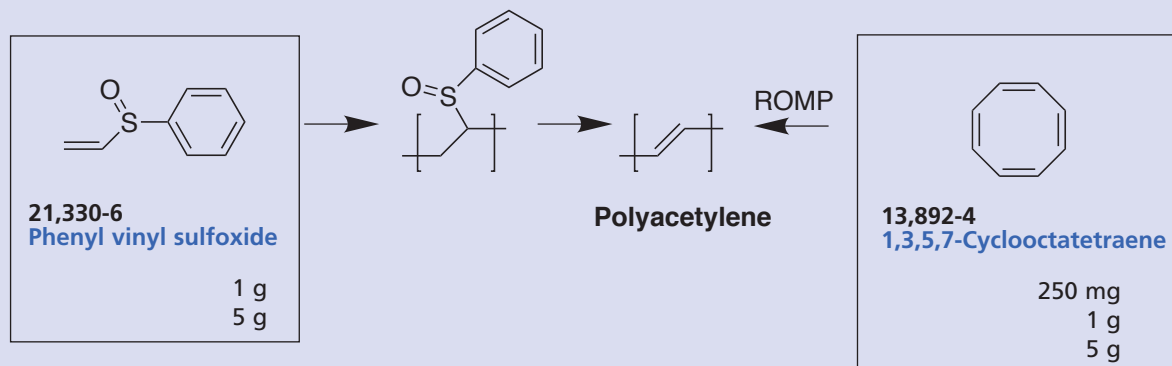


Polyacetylenes

The simplest π conjugated polymer. In 1977 Heeger, MacDiarmid and Shirakawa discovered that polyacetylene becomes conductive upon doping with bromine or iodine vapor.¹³ This discovery opened up the field of conductive polymer research and the trio were awarded the 2000 Nobel Prize in chemistry. Polyacetylene can be regarded as an intrinsic semiconductor with a band gap of 1.5 eV.

Polyacetylene Synthesis

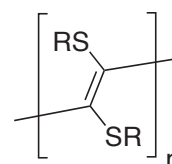
Polyacetylene can be formed by either polymerization of phenyl vinyl sulfoxide, followed by removal of benzenesulfinic acid, or by ring-opening metathesis polymerization (ROMP) of cyclooctatetraene.



Polythioacetylenes

Polythioacetylenes are a soluble, processable derivative of polyacetylene. When irradiated with laser light, the polymers exhibit conductivities from 10-200 S/cm.

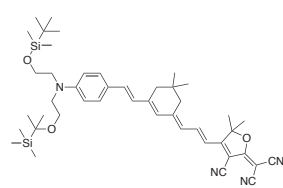
Catalog #	Polyacetylene Products	Avg. Mn*	R group	Size
44,600-9	Poly(bis(methylthio)acetylene)	4000	-CH ₃	50 mg 250 mg
44,601-7	Poly(bis(ethylthio)acetylene)	1200	-CH ₂ CH ₃	50 mg 250 mg
44,602-5	Poly(bis(benzylthio)acetylene)	900		100 mg 250 mg



*by vapor pressure osmometry (vpo)

New Technologies for OLEDs

CLD-1 Dye and Ready-to-Cast Solution



64,413-7

CLD-1

100 mg

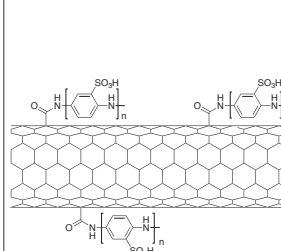
CLD-1 is a high $\mu\beta$ chromophore possessing excellent thermal stability, low optical loss and low modulation voltage. Now Sigma-Aldrich offers CLD-1 as a powder and as a ready-to-cast solution with an amorphous poly-carbonate (APC) support.

65,158-3

10% CLD-1 in Dichloroethane
(25% solids with APC support)

5 mL

Water Soluble Carbon Nanotubes



NEW single walled carbon nanotubes coated in a water soluble conductive polymer to aid in solution processing.

Solubility in H₂O = 5.0 mg/mL

63,923-0

Carbon nanotube, single-walled, polyamino benzene sulfonic acid coating (65/35)

50 mg

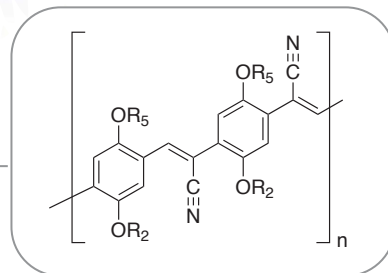


To discuss how our expertise can benefit your next scale-up project or to obtain a quote, contact your local Sigma-Aldrich office or visit www.safglobal.com

Light-Emitting Polymers

Cyano-Polyphenylene vinylenes (CN-PPV)

CN-PPV acts as the electron accepting material in light emitting polymer heterojunctions. OLEDs incorporating CN-PPV exhibit quantum efficiencies of ~30%.



Poly(2,5-di(3,7-dimethyloctyloxy)-cyanoterephthalylidene)

64,657-1 250 mg

Poly(5-(3,7-dimethyloctyloxy)-2-methoxy-cyanoterephthalylidene)

64,662-8 250 mg

Poly(5-(2-ethylhexyloxy)-2-methoxy-cyanoterephthalylidene)

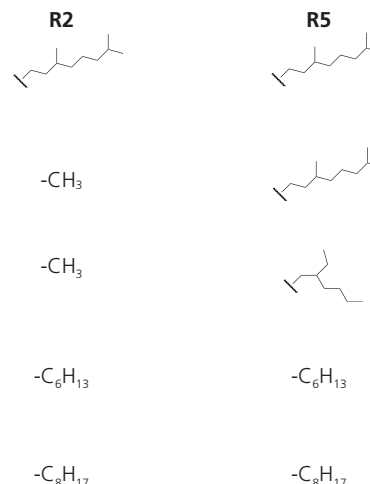
64,664-4 250 mg

Poly(2,5-di(hexyloxy)cyanoterephthalylidene)

64,665-2 250 mg

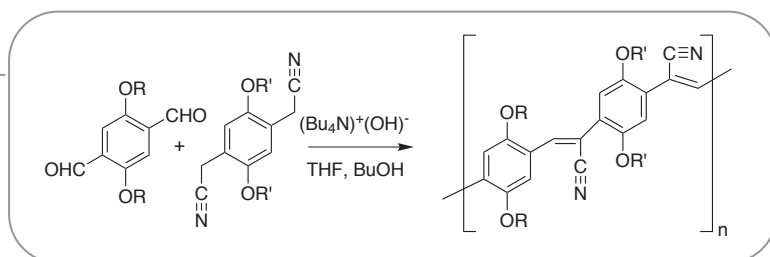
Poly(2,5-di(octyloxy)cyanoterephthalylidene)

64,666-0 250 mg



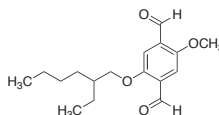
Monomers for CN-PPV

Sigma-Aldrich has a wide selection of monomers for Knoevenagel condensation to CN-PPV. If you don't see the monomer you need, send a suggestion to matsci@sial.com.



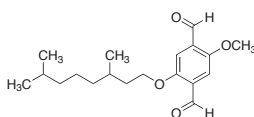
2-Methoxy-5-(2'-ethylhexyloxy) terephthalaldehyde

56,079-0 1 g



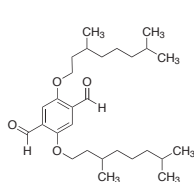
2-Methoxy-5-(3',7'-dimethyloctyloxy) terephthalaldehyde

56,078-2 1 g



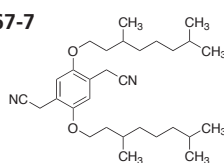
2,5-Bis(3',7'-dimethyloctyloxy) terephthalaldehyde

56,077-4 1 g



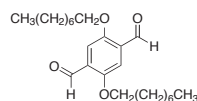
2,5-Bis(3',7'-dimethyloctyloxy) benzene-1,4-diacetonitrile

56,067-7 1 g



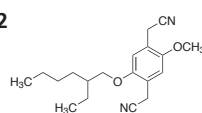
2,5-Bis(octyloxy)terephthalaldehyde

56,671-3 1 g



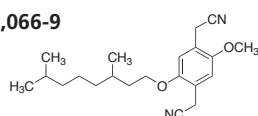
2-Methoxy-5-(2'-ethylhexyloxy) benzene-1,4-diacetonitrile

56,064-2 1 g



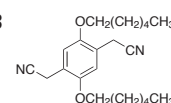
2-Methoxy-5-(3',7'-dimethyloctyloxy) benzene-1,4-diacetonitrile

56,066-9 1 g



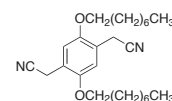
2,5-Bis(hexyloxy)benzene-1,4-diacetonitrile

56,069-3 1 g



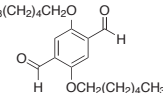
2,5-Bis(octyloxy)benzene-1,4-diacetonitrile

56,672-1 1 g



2,5-Bis(hexyloxy)terephthalaldehyde

56,076-6 1 g

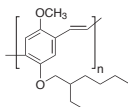


Polyphenylene vinylenes (PPV)

Among the best studied light emitting conjugated polymers, PPV combines good mechanical and processing properties with excellent luminescent abilities.¹⁴ Substitution of the intractable PPV backbone with alkyl and alkoxy substituents improves the solubility and tunes the optical band gap. PPV derivatives are commonly employed as the electroluminescent layer in LEPs used in mobile phones. Sigma-Aldrich presents a range of substituted PPVs and PPV co-polymers to combine emission color characteristics and processing requirements.

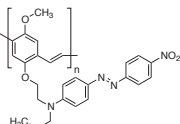
Poly(2-methoxy-5-(2'-ethylhexyloxy)-1,4-phenylenevinylene) MEH-PPV

Catalog #	Avg Mn	λ_{\max} (nm)	Size
54,144-3	51,000	497	1 g
54,143-5	86,000	497	1 g
53,651-2	125,000	498	1 g



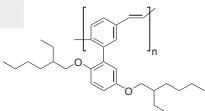
Poly(1-methoxy-4-(o-disperse red 1))-2,5-phenylenevinylene

63,032-2			100 mg
λ_{\max} (nm): 465			500 mg



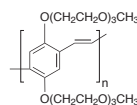
Poly(2-(2',5'-bis(2"-ethylhexyloxy)phenyl)-1,4-phenylenevinylene), BEHP-PPV

54,661-5			1 g
λ_{\max} (nm): 278			



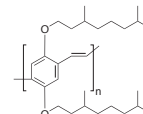
Poly(2,5-bis(1,4,7,10-tetraoxaundecyl)-1,4-phenylenevinylene)

64,421-8			1 g
λ_{\max} (nm): 510			



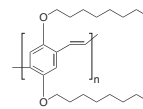
Poly(2,5-bis(3',7'-dimethyloctyloxy)-1,4-phenylenevinylene)

54,651-8			1 g
λ_{\max} (nm): 488			



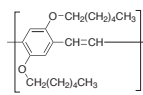
Poly(2,5-bis(octyloxy)-1,4-phenylenevinylene)

55,503-7			1 g
λ_{\max} (nm): 491			



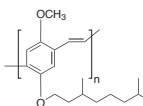
Poly(2,5-dihexyloxy-1,4-phenylenevinylene)

56,080-4			1 g
λ_{\max} (nm): 496			



Poly(2-methoxy-5-(3',7'-dimethyloctyloxy)-1,4-phenylenevinylene)

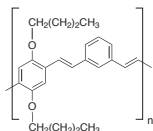
54,646-1			1 g
λ_{\max} (nm): 491			



PPV Copolymers

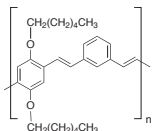
Poly(m-phenylenevinylene)-alt-(2,5-dibutoxy-p-phenylenevinylene)

57,540-2			1 g
λ_{\max} (nm): 403			



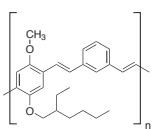
Poly(m-phenylenevinylene)-alt-(2,5-dihexyloxy-p-phenylenevinylene)

57,541-0			1 g
λ_{\max} (nm): 403			



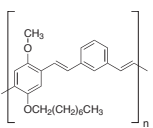
Poly(m-phenylenevinylene)-alt-(2-methoxy-5-(2-ethylhexyloxy)-p-phenylenevinylene)

59,431-8			1 g
λ_{\max} (nm): 401			



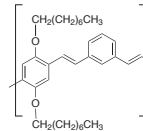
Poly(m-phenylenevinylene)-alt-(2-methoxy-5-octyloxy-p-phenylenevinylene)

59,441-5			1 g
λ_{\max} (nm): 399			



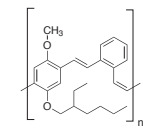
Poly(m-phenylenevinylene)-co-(2,5-dioctyloxy-p-phenylenevinylene)

55,516-9			1 g
λ_{\max} (nm): 402			



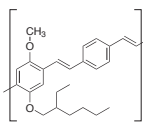
Poly[(o-phenylenevinylene)-alt-(2-methoxy-5-(2-ethylhexyloxy)-p-phenylenevinylene)]

59,408-3			1 g
λ_{\max} (nm): 385			



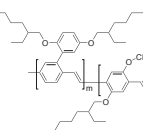
Poly[(p-phenylenevinylene)-alt-(2-methoxy-5-(2-ethylhexyloxy)-p-phenylenevinylene)]

59,419-9			1 g
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Poly{[2-[2',5'-bis(2"-ethylhexyloxy)phenyl]-1,4-phenylenevinylene]-co-[2-methoxy-5-(2'-ethylhexyloxy)-1,4-phenylenevinylene]}

57,026-5			1 g
λ_{\max} (nm): 492			



Contact us at matsci@sial.com to request absorption and photoluminescence spectra or additional analytical data of any light emitting material in this brochure.



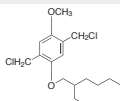
To discuss how our expertise can benefit your next scale-up project or to obtain a quote, contact your local Sigma-Aldrich office or visit www.safcglobal.com

PPV Monomers

PPV materials are often prepared by the Wessling sulfonium precursor route,* which yields PPVs upon heating cast films of the precursors. An alternate route is the solution phase dehydrohalogenation method. Sigma-Aldrich offers several precursors for your PPV synthesis.

2,5-Bis(chloromethyl)-1-methoxy-4-(2-ethylhexyloxy)benzene, 98%

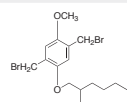
53,625-0



1 g

2,5-Bis(bromomethyl)-1-methoxy-4-(2-ethylhexyloxy)benzene, 98%

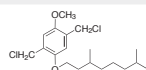
53,653-9



1 g

2,5-Bis(chloromethyl)-1-methoxy-4-(3',7'-dimethyloctyloxy)benzene, 98%

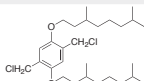
54,644-5



1 g

2,5-Bis(chloromethyl)-1,4-bis(3',7'-dimethyloctyloxy)benzene, 98%

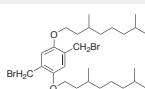
54,648-8



1 g

2,5-Bis(bromomethyl)-1,4-bis(3',7'-dimethyloctyloxy)benzene, 98%

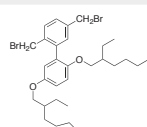
54,649-6



1 g

2,5-Bis(bromomethyl)-2',5'-bis(2-ethylhexyloxy)-1,1'-biphenyl, 98%

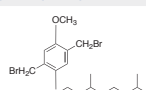
54,660-7



1 g

2,5-Bis(bromomethyl)-1-methoxy-4-(3',7'-dimethyloctyloxy)benzene, 98%

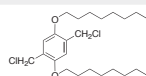
54,645-3



1 g

2,5-Bis(chloromethyl)-1,4-bis(octyloxy)benzene, 98%

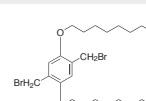
55,505-3



1 g

2,5-Bis(bromomethyl)-1,4-bis(octyloxy)benzene, 98%

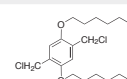
55,504-5



1 g

2,5-Bis(chloromethyl)-1,4-bis(hexyloxy)benzene, 98%

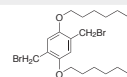
56,073-1



1 g

2,5-Bis(bromomethyl)-1,4-bis(hexyloxy)benzene, 98%

56,075-8



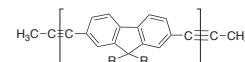
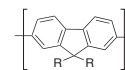
1 g

*Poly(p-xylylene tetrahydrothiophenium chloride) is available as a film (54,077-3) or solution (54,076-5). For this and phosphonium monomers to PPV, contact us at matsci@sial.com.

Polyfluorenes (PFO, PFE)

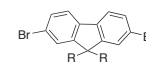
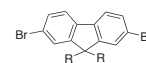
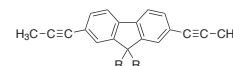
Alkylpolyfluorenes are an attractive class of conjugated polymers for OLED applications, because of their pure blue emission and efficient electroluminescence coupled with a high charge-carrier mobility and good processability.

Catalog #	Polyacetylene Products	R	Size
57,103-2	Poly[9,9-di-(2'-ethylhexyl)fluorenyl-2,7'-diyl]	-C ₆ H ₁₃	1 g
57,104-0	Poly[9,9-di-n-hexylfluorenyl-2,7'-diyl]	-C ₆ H ₁₃	1 g
57,165-2	Poly[9,9-di-n-octylfluorenyl-2,7'-diyl]	-C ₈ H ₁₇	500 mg
57,166-0	Poly[9,9-di-n-dodecylfluorenyl-2,7'-diyl]	-C ₁₂ H ₂₅	500 mg
54,658-5	Poly[9,9-dioctylfluorenyl-2,7-yleneethynylene]	-C ₈ H ₁₉	500 mg
55,499-5	Poly[9,9-di(2'-ethylhexyl)fluorenyl-2,7-yleneethynylene]		500 mg
55,497-9	Poly[9,9-di(3',7'-dimethyloctyl)fluorenyl-2,7-yleneethynylene]		500 mg
55,500-2	Poly[9,9-didodecylfluorenyl-2,7-yleneethynylene]	-C ₁₂ H ₂₅	500 mg



Monomers for PFO/PFE synthesis

Catalog #	Polyacetylene Products	R	Size
54,662-3	9,9-Dioctyl-2,7-di-1-propynyl-9H-fluorene, 98%	-C ₈ H ₁₇	500 mg
55,496-0	9,9-Didodecyl-2,7-di-1-propynyl-9H-fluorene, 98%	-C ₁₂ H ₂₅	500 mg
55,501-0	9,9-Di(3',7'-dimethyloctyl)-2,7-di-1-propynyl-9H-fluorene, 98%		500 mg
55,502-9	9,9-Di(2'-ethylhexyl)-2,7-di-1-propynyl-9H-fluorene, 98%		500 mg
57,206-3	9,9-Didodecylfluorene-2,7-bis(trimethylene borate) 0.5M solution in toluene	-C ₁₂ H ₂₅	25 mL
56,935-6	9,9-Dihexylfluorene-2,7-bis(trimethyleneborate)	-C ₈ H ₁₇	5 g
56,668-3	9,9-Dihexylfluorene-2,7-bis(trimethyleneborate)	-C ₆ H ₁₃	5 g
57,207-1	9,9-Di(2'-ethylhexyl)fluorene-2,7-bis(trimethylene borate) solution (0.5 M in Toluene)		25 mL
56,005-7	9,9-Didodecyl-2,7-dibromofluorene	-C ₁₂ H ₂₅	25g
56,007-3	9,9-Dioctyl-2,7-dibromofluorene	-C ₈ H ₁₇	25g
56,006-5	9,9-Dihexyl-2,7-dibromofluorene	-C ₆ H ₁₃	25g
56,008-1	9,9-Di(2'-ethylhexyl)-2,7-dibromofluorene		25g



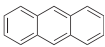
To order: Contact your local Sigma-Aldrich office (see back cover), or visit sigma-aldrich.com.

Charge Transport Materials

Semiconducting Small Molecules

OLEDs and OFETs are commercially available because of these high-charge mobility materials. The aromatic oligomers form well ordered crystalline films of high purity through vacuum processing. Sigma-Aldrich can prepare these materials with extremely low metals content for electronic grade applications. We have additional products not listed below, so if you don't see something you need, contact your local Sigma-Aldrich office or visit our on-line catalog at sigma-aldrich.com/matsci.

Anthracene, Zone Refined, 99+%

33,148-1  250 mg
1 g

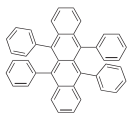
CAS NO: 120-12-7
MF: C₁₄H₁₀
FW: 178.23
mp: 216-218 °C

Rubrene

55,407-3, 98+% 100 mg
500 mg

55,111-2, sublimed 100 mg
500 mg

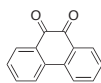
CAS NO: 517-51-1
MF: C₄₂H₂₈
FW: 532.69
mp: >315 °C



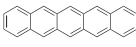
9,10 Phenanthrenequinone, 99+%

15,650-7 5 g
25 g

CAS NO: 84-11-7
MF: C₁₄H₈O₂
FW: 208.22
mp: 209-211 °C

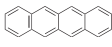


Pentacene

P180-2  50 mg
100 mg
1 g

CAS NO: 135-48-8
MF: C₂₂H₁₄
FW: 278.35
mp: >300 °C

2,3-Benzanthracene, 98% (tetracene)

B240-3  100 mg
500 mg
1 g

CAS NO: 92-24-0
MF: C₁₈H₁₂
FW: 228.29
mp: >300 °C


Triphenylene, 98%

T8,260-0 250 mg
1 g

CAS NO: 217-59-4
MF: C₁₈H₁₂
FW: 228.29
mp: 197-200 °C



Phenanthrene, 99.5+%

26,087-8  500 mg
1 g

CAS NO: 85-01-8
MF: C₁₄H₁₀
FW: 178.23
mp: 99-101 °C

Perylene, 99.5+%

39,447-5 1 g
5 g

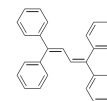
CAS NO: 198-55-0
MF: C₂₀H₁₂
FW: 252.32
mp: 278-280 °C (dec)



1,1,4,4-Tetraphenyl-1,3-butadiene, 99+%

18,521-3 1 g
5 g

CAS NO: 1450-63-1
MF: C₂₈H₂₂
FW: 358.49
mp: 207-209 °C



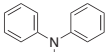
Hole Transport Materials (HTM)

Sigma-Aldrich features a wide variety of molecular organic and organometallic HTMs. We also have precursors to several¹⁵ polyarylamines. As always, if you need a new HTM not listed here, "please bother us," at matsci@sial.com.


N,N'-Bis(3-methylphenyl)-N,N'-diphenylbenzidine, (TPD), 99%


44,326-3  1 g
5 g

Triphenylamine, 98%

T8,160-4  25 g
100 g

Poly(1-vinylnaphthalene), average Mn. ca. 100,000

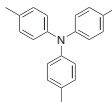
19,196-5  1 g
Mn=100,000

54,145-1  1 g
Mn=30,000

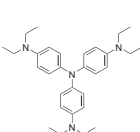
N,N'-Di-[(1-naphthalenyl)-N,N'-diphenyl]-1,1'-biphenyl-4,4'-diamine, (NPD) sublimed grade, 99%

55,669-6  500 mg

Tri-p-tolylamine, 97%

45,976-3  1 g
5 g

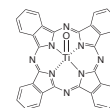
Tris(4-(diethylamino)phenyl)amine, 99+%

55,639-4  1 g
10 g

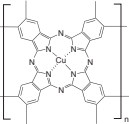
Titanyl phthalocyanine

40,455-1 250 mg
95% Dye Content 1 g

55,618-1 250 mg
γ-modification 1 g



Copper phthalocyanine polymer, 60% dye content

52,762-9  1 g
5 g

N,N'-Diphenylbenzidine, 97%

D20,520-6  10 g



To discuss how our expertise can benefit your next scale-up project or to obtain a quote, contact your local Sigma-Aldrich office or visit www.safcglob.com

For technical assistance or to order: please call your local Sigma-Aldrich office

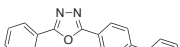
Semiconducting Small Molecules
Hole Transport Materials

ALDRICH®

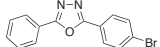
Electron Transport Materials (ETM)

ETMs find utility in OLEDs as hole-blocking materials and when co-polymerized with fluorenes as efficient electron transport materials.

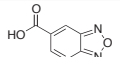
2-(4-Biphenyl)-5-phenyl-1,3,4-oxadiazole, (PBD), 99%

25,785-0  1 g
25 g

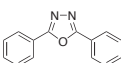
2-(4-Bromophenyl)-5-phenyl-1,3,4-oxadiazole, 96%

55,364-6  1 g
5 g

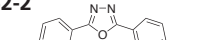
2,1,3-Benzoxadiazole-5-carboxylic acid, 97%

55,661-0  500 mg

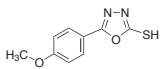
2,5-Diphenyl-1,3,4-oxadiazole, 97%

D21,021-8  1 g
5 g

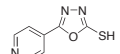
2,5-Bis(4-aminophenyl)-1,3,4-oxadiazole

33,352-2  250 mg
1 g

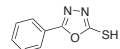
5-(4-Methoxyphenyl)-1,3,4-oxadiazole-2-thiol, 97%

54,896-0  25 g

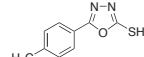
5-(4-Pyridyl)-1,3,4-oxadiazole-2-thiol, 97%

43,856-1  1 g
10 g

5-Phenyl-1,3,4-oxadiazole-2-thiol, 97%

39,180-8  5 g
25 g

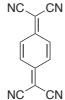
5-(4-Methylphenyl)-1,3,4-oxadiazole-2-thiol, 97%

54,895-2  5 g
25 g


Hole Injection Materials*

The TCN family of molecules are some of the best known electron accepting molecules used in charge transfer superconductors. They are also used as a barrier between ITO and HTMs to enhance charge injection, improving device efficiency.

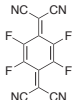
7,7,8,8-Tetracyanoquinodimethane, (TCNQ), 98%

15,763-5  1 g
5 g
10 g

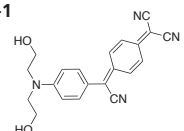
Tetracyanoethylene, (TCNE), 98%

T,880-9  1 g
5 g
10 g
25 g

2,3,5,6-Tetrafluoro-7,7,8,8-tetracyanoquinodimethane (TCNQF4), 97%

37,677-9  5 mg
25 mg

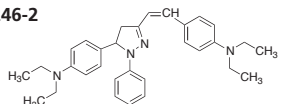
2-[4-((Bis(2-hydroxyethyl)aminophenyl)-cyanomethylene)-2,5-cyclohexadien-1-ylidene]malononitrile

57,210-1  5 mg
25 mg

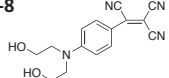
*(PEDOT:PSS is listed on page 1) Electron acceptors for superconducting materials in the Additional CT Materials table below.

Additional Photosensitizing and CT Materials


(Diethylamino)phenyldihydrophenylpyrazol-yl-ethenyl-N,N-diethylaniline

46,246-2  1 g

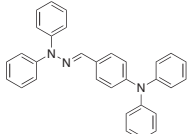
4-[Bis(2-hydroxyethyl)amino]phenyl]-1,1,2-ethylenetricarbonitrile

57,212-8  50 mg
250 mg


1-Vinylnaphthalene, 95%

53,058-1  1 g
5 g

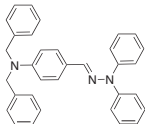
4-(Diphenylamino)benzaldehyde diphenylhydrazone, 97%

46,244-6  1 g

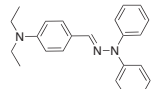
Phenothiazine, 98%+

P1,483-1  25 g
500 g
1 kg

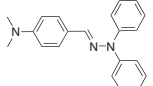
4-(Dibenzylamino)benzaldehyde diphenylhydrazone, 97%

54,836-7  1 g

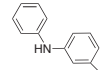
4-(Diethylamino)benzaldehyde diphenylhydrazone, 97%

46,243-8  1 g
25 g

4-(Dimethylamino)benzaldehyde diphenylhydrazone, 97%

46,241-1  1 g


3-Methyldiphenylamine, 98%

18,351-2  10 g
50 g

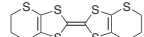
Di-p-tolylamine, 97%

46,108-3  5 g
25 g

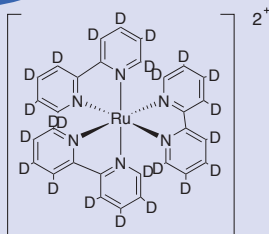
Tetrathiafulvalene, (TTF), 97%

18,318-0  100 mg
250 mg
1 g

Bis(ethylenedithio)tetrathiafulvalene (BEDT-TTF), 98%

36,202-6  100 mg
500 mg

NEW



Tris(2,2'-bipyridyl-d₈)ruthenium(II) hexafluorophosphate, 99%

Deuteration of the bipyridine ligand improves the emission lifetime and quantum efficiency of the triplet emission by reducing energy losses through C-H bond vibrations. The quantum efficiencies are 20% greater than the undeuterated analog.¹⁶ Sigma-Aldrich presents our newest technology for OLED and sensor applications.

65,240-7

100 mg
500 mgMW: C₃₀D₂₄F₁₂N₆P₂Ru
mp: >300°C
lmax: 455nm

Light-Emitting Metal Complexes

Metal complexes are the key electron transport and emission materials for OLEDs. Europium complexes (red), Alq₃ (green) and LiBq₄ (blue) provide the complete spectrum of emission colors. The triplet emitting ruthenium complexes are also used in sensor applications. Have a complex in mind, but can't find it? Contact matsci@sial.com, we welcome your product suggestions.

8-hydroxyquinoline, aluminum salt, Alq₃, 99.995%

44,456-1

1 g
5 g

CAS NO: 2085-33-8

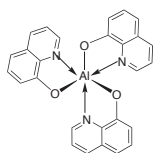
MF: C₁₇H₁₂AlN₃O₃

FW: 459.44

mp: 408-410 °C

Application: Electroluminescent
Green Emitter

λ max (Emis): 511 nm (ITO Film)



8-Hydroxyquinoline, zinc salt, Znq₂, 99%

47,175-5

5 g
25 g

CAS NO: 13978-85-3

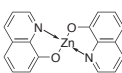
MF: C₁₈H₁₂N₂O₂Zn

FW: 353.7

mp: 354-356 °C

Application: Electroluminescent
Yellow Emitter

λ max (Emis): 544 nm (in THF)



Copper(II) phthalocyanine, 99% (dye content) Sublimation Grade

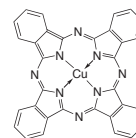
54,668-2

200 mg
2 g

CAS NO: 147-14-8

MF: C₁₈H₈CuN₈

FW: 576.07



Lithium tetra(8-hydroxyquinolinato)boron, 98%

53,892-2

100 mg

CAS NO: 322727-85-5

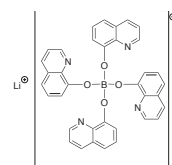
MF: C₃₂H₂₄BN₈O₄Li

FW: 594.4

mp: 240-241 °C

Application: Electroluminescent
Blue Emitter

λ max (Emis): 512 nm (THF)



Lithium tetra(2-methyl-8-hydroxyquinolinato)boron, 98%

53,891-4

100 mg

CAS NO: 338949-42-1

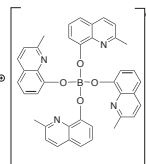
MF: C₄₀H₃₂BN₈O₄Li

FW: 650.5

mp: 224-225 °C

Application: Electroluminescent
Blue Emitter

λ max (Emis): 504 nm (THF)



Dichlorotriscis(1,10-phenanthroline) ruthenium(II) hydrate, 98%

34,371-4

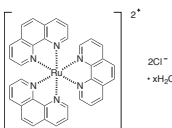
1 g
5 g

CAS NO: 304695-79-2

MF: C₃₆H₂₄Cl₂N₆Ru

FW: 712.61

Application: Triplet Emitter



Tris(dibenzoylmethane)mono(5-aminophenanthroline) europium(III)

53,897-3

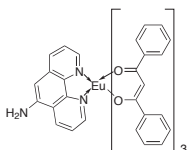
100 mg

CAS NO: 352546-68-0

MF: C₃₇H₂₈EuN₅O₆

FW: 1017.95

mp: 163-168 °C

Application: Triplet
Red Emitterλ max (Emis): 612 nm (H₂O)

Chlorobis(2-phenylpyridine)rhodium(III)

41,907-9

250 mg
1 g

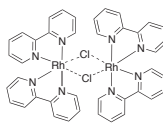
CAS NO: 33915-80-9

MF: C₂₄H₁₈Cl₂N₄Rh₂

FW: 893.49

mp: 270 dec.

Application: Triplet Emitter



Tris(dibenzoylmethane)mono(phenanthroline) europium(III)

53,896-5

100 mg

CAS NO: 17904-83-5

MF: C₃₇H₂₈EuN₃O₆

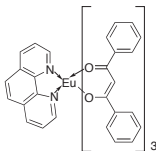
FW: 1001.93

mp: 172-173 °C

Application: Triplet

Red Emitter

λ max (Emis): 608 nm (THF)



Cis-bis(2,2'-bipyridine)dichlororuthenium(II) hydrate

28,812-8

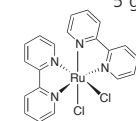
500 mg
5 g

CAS NO: 98014-14-3

MF: C₂₂H₁₆Cl₂N₄Ru

FW: 484.36

Application: Triplet Emitter



Tris(2,2'-bipyridyl)dichlororuthenium(II) hexa hydrate, 99.95%

54,498-1

250 mg
1 g

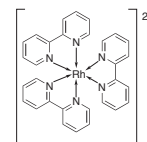
CAS NO: 50525-27-4

MF: C₃₆H₂₄Cl₂N₆Ru

FW: 748.63

mp: >300 °C

Application: Triplet Emitter



Tris(benzoylacetato)mono(phenanthroline) europium(III)

53,895-7

100 mg

CAS NO: 18130-95-5

MF: C₃₈H₂₈EuN₃O₆

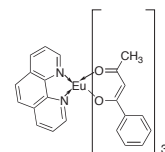
FW: 818.7

mp: 191-192 °C

Application: Triplet

Red Emitter

λ max (Emis): 611 nm (THF)



Using Alq₃? Improve your efficiency.

Alq₃ is the choice electron transport material and green emission layer material for OLED applications because of its stability, processability and fluorescence properties.¹⁷ Alq₃ performance can be improved by employing dopants like DMQA or BCP to improve luminous and power efficiency, and emission lifetime.

5,12-Dihydro-5,12-dimethylquino[2,3-b]acridine-7,14-dione (DMQA)

55,758-7

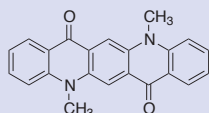
100 mg
500 mg

CAS NO: 19205-19-7

MF: C₂₂H₁₆N₂O₂

FW: 340.37

mp: 285.8°C (dec)



2,9-Dimethyl-4,7-diphenyl-1,10-phenanthroline, 96% (Bathocuproine or BCP)

14,091-0

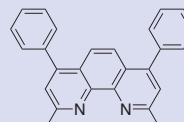
500 mg
1 g

CAS NO: 4733-39-5

MF: C₂₆H₂₀N₂

FW: 360.46

mp: 279-283°C (dec)



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Light-Emitting
Metal Complexes

ALDRICH®

Spin-Coating Equipment

These compatible, easy-to-use devices provide a convenient step-by-step method for processing metalorganic polymer solutions. The dispenser releases accurately measured amounts onto the precision spin-coater. The hot plate and UV curer are then used to bake or cure your thin film or coating. This simple system can be used to deposit metal oxide thin films, polymer coatings, and metal organic thin films. 220V equipment is CE compliant.



Precision Spin-Coater

A two-stage spin process allows dispensing at low speeds and homogenizing the coating at high speeds. Dim.: 8 ½ W x 8 ½ H x 10in.D.

Specifications

Vacuum:	>2.1CFM
Speed stability:	<1%
Stage 1:	500-2,500rpm 2-18 seconds
Stage 2:	1,000-8,000rpm 3-60 seconds

Volts	Cat. No.
115V	Z55,156-2
220V	Z55,158-9



Compact Hot Plate

The portable design is convenient to be used in conjunction with the spin-coater. Has digital display and internal thermocouple. Plate dim: 6 x 6in.

Specifications

Temp. Resolution:	1°C
Temp. Range:	120-660°F

Volts	Cat. No.
110V	Z55,159-7
220V	Z55,160-0



UV Curer

2 tubes. Dim.: 8 ¼ x 9 ½ in.

Specifications

UV Wavelength:	254nm
Power output:	4 watts/tube
Turn plate:	6rpm

Volts	Cat. No.
110V	Z55,161-9
220V	Z55,162-7



Dispenser

Dim.: 8 ¼ x 9 ½ x 4in.

Specifications

Air:	80-100psi
Air port:	Quick-connect

Volts	Cat. No.
110V	Z55,163-5
220V	Z55,164-3

Accessories

Vacuum pump	Z55,167-8
Environmental control chamber	Z55,171-6

Type CG vacuum chucks

Diam.	Cat. No.
1in.	Z55,168-6
1 ½ in.	Z55,169-4
2in.	Z55,170-8

OLED Substrates

Indium Tin Oxide Coated Substrates

Catalog #	Substrate Type	Surface Resistance (sq Ω)	Dimensions ⁴	Passivation Layer (\AA , SiO_2)	ITO Thickness (\AA)	Optical Transmittance (%)
57,827-4	Glass ¹ slide	8-12	25 X 75 X 1.1 mm	200-300	1200-1600	>83
63,691-6	Glass ¹ slide	15-25	25 X 75 X 1.1 mm	200-300	600-1000	>78
63,690-8	Glass ¹ slide	30-60	25 X 75 X 1.1 mm	200-300	300-600	>84
57,635-2	Glass ¹ slide	70-100	25 X 75 X 1.1 mm	200-300	150-300	>87
57,636-0	Aluminosilicate ² glass slide	5-15	25 X 75 X 1.1 mm	none	1200-1600	>85
63,693-2	PET ³ slide	8-12	25 X 75 X 1.1 mm	none	1200-1600	>74
63,692-4	PET ³ slide	60-100	25 X 75 X 1.1 mm	none	150-300	>76
63,931-1	PET ³ sheet	40-45	1 ft X 1 ft X 5 mil	none	1200	>86
63,930-3	PET ³ sheet	50-70	1 ft X 1 ft X 5 mil	none	1000	>79
63,928-1	PET ³ sheet	90-110	1 ft X 1 ft X 5 mil	none	750	>77

1) Typical composition of slide is 72.6% SiO_2 , 0.8% B_2O_3 , 1.7% Al_2O_3 , 4.6% CaO, 3.6% MgO, and 15.2% Na_2O

2) Typical composition of slide is 55.0% SiO_2 , 7.0% B_2O_3 , 10.4% Al_2O_3 , 21.0% CaO, and 1.0% Na_2O

3) PET = poly(ethylene terephthalate)

4) 5 mil = 0.125 mm

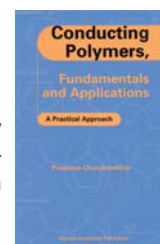
Books

Conducting Polymers, Fundamentals and Applications: A Practical Approach

P. Chandrasekhar, Kluwer Academic Publishing, 1999, 760pp., Hardcover

Conducting polymers is utilizing the unique electronic properties of a class of easily synthesized, primarily organic materials with the predominant property of high and controllable conductivity and subsidiary properties emanating from this conductivity and the associated causative electronic structure. This book deals with the practical fundamentals and applications of conducting polymers.

Z42,253-3

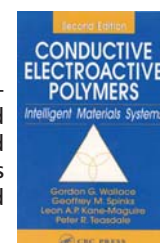


Conductive Electroactive Polymers: Intelligent Materials Systems, 2nd ed.

G. G. Wallace, G. M. Spinks, L. A. P. Kane-McGuire, and P. R. Teasdale, CRC Press, 2002, 248pp., Hardcover

This book provides a thorough, up-to-date introduction to conductive electroactive polymers. The authors discuss the parameters that affect the formation of important CEPs, including polypyrroles, polyanilines, and polythiophenes. They show how to use these parameters to manipulate the properties of the polymers, and they clarify the chemical and energy parameters that determine the structure and its properties. New in this edition are more details on polythiophene and polyaniline systems, an update on progress in polypyrroles, and reports on recent advances in CEP processing techniques and device fabrication.

Z55,218-6



Handbook of Luminescence, Display, Materials, and Devices, 3-volume set

H. S. Nalwa, American Scientific Publishers, 2003, 1200pp., Hardcover

This book provides coverage on various aspects of organic and inorganic luminescent materials and devices. Includes organic light emitting diodes (OLEDs) and inorganic display devices including materials synthetic strategies, processing and fabrication methods, screening methods, and much more.

Z54,768-9

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