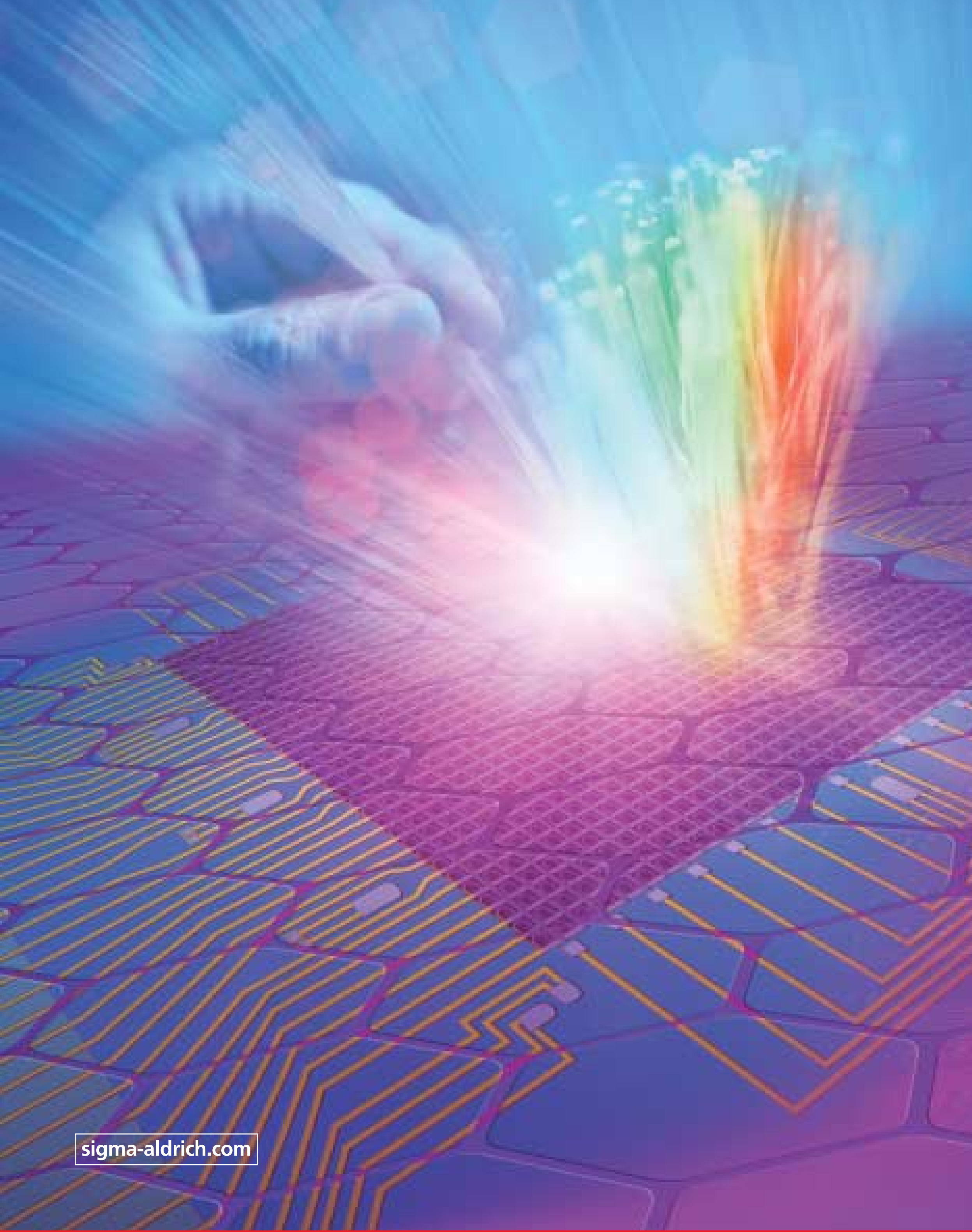
ChemFiles

Vol. 3 No. 8

Advanced Polymers for Electronic/Optical Devices

New Additions for 2004



High and Low Refractive Index Polymers & Monomers

NLO Polymers

Photoluminescent Conjugated Polymers

Light-Emitting Dopants/ Fluorescent Dyes

FITC-Functionalized Polyelectrolytes for SAMs

Spin-Coating System

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High and Low Refractive Index Polymers & Monomers

Refractive index is of critical importance for applications such as optical waveguides and ophthalmic devices.[1] With trends towards higher transmission speed, data capacity and data density in integrated circuits, optical polymeric materials are showing promise towards solving the data bottlenecks associated with electrical interconnects.[2] Based on their unique refractive index characteristics these same materials are also finding use as anti-reflective coatings for solar cells and contact lenses.[1] With the need for mechanical strength, environmental stability and optical damage threshold, polymeric-based materials offer excellent potential as alternatives to traditional optical materials.[3] Other advantages over their inorganic counterparts include relative ease of processing, light weight, insensitivity to vibrational stress and low cost.

Aldrich offers a range of high refractive index polymers, based on aromatic and brominated aromatic monomers, as well as low refractive polymers based on fluorinated monomers. The associated monomers are likewise available, for producing copolymers whose refractive index can be tailored. Also listed are UV/thermal crosslinkable polymers for patterning or heterolayered device fabrication. These products are highlighted below, listed in order of refractive index. The subsequent sections provide chemical structure and unit sizes for each product.

High Refractive Index Materials

Name	n_D^{20}	Tg (°C)	Homopolymer	Photo Crosslinkable Polymer	Monomer
Poly(pentabromophenyl methacrylate)	1.710¥	—	59,206-4	59,183-1 59,161-0	59,243-9
Poly(pentabromophenyl acrylate)	—	155	59,152-1	59,150-5 59,140-8	59,255-2
Poly(pentabromobenzyl methacrylate)	1.710¥	—	64,030-1	64,029-8	64,033-6
Poly(pentabromobenzyl acrylate)	1.670¥	180¥	64,032-8	—	64,026-3
Poly(2,4,6-tribromophenyl methacrylate)	1.660¥	—	64,024-7	64,025-5	64,023-9
Poly(vinylphenylsulfide)	1.657¥	113	64,021-2	64,022-0	—
Poly(1-naphthylmethacrylate)	1.641¥	205	64,019-0	64,020-4	—
Poly(2-vinylthiophene)	1.638¥	—	64,018-2	—	—
Poly(2,6-dichlorostyrene)	1.625¥	167¥	63,997-4	64,017-4	D7,450-9
Poly(N-vinylphthalimide)	1.620¥	201	63,998-2	—	34,954-2
Poly(2-chlorostyrene)	1.610¥	103	64,001-8	—	16,067-9
Poly(pentachlorophenyl methacrylate)	1.608¥	—	64,003-4	—	—

Low Refractive Index Materials

Name	n_D^{20}	Tg (°C)	Homopolymer	Photo Crosslinkable Polymer	Monomer
Poly(1,1,1,3,3,3-hexafluoroisopropyl acrylate)	1.375¥	-23	63,015-2	—	36,765-6
Poly(2,2,3,3,4,4,4-heptafluorobutyl acrylate)	1.377¥	-30¥	63,017-9	—	44,375-1
Poly(2,2,3,3,4,4,4-heptafluorobutyl methacrylate)	1.383†	65†	59,197-1	59,210-2 59,209-9	44,400-6
Poly(2,2,3,3,3-pentafluoropropyl acrylate)	1.389¥	-26¥	63,013-6	—	47,096-1
Poly(1,1,1,3,3,3-hexafluoroisopropyl methacrylate)	1.390†	56†	59,132-7	59,154-8 59,143-2	36,766-4
Poly(2,2,3,4,4,4-hexafluorobutyl acrylate)	1.394¥	-22¥	63,016-0	—	47,445-2
Poly(2,2,3,4,4,4-hexafluorobutyl methacrylate)	—	—	59,164-5	59,187-4 59,176-9	37,197-1
Poly(2,2,3,3,3-pentafluoropropyl methacrylate)	1.395†	70†	59,208-0	59,089-4 59,110-6	47,419-3
Poly(2,2,2-trifluoroethyl acrylate)	1.411¥	-10¥	63,009-8	—	29,772-0
Poly(2,2,3,3-tetrafluoropropyl acrylate)	1.415¥	-22	63,014-4	—	37,192-0
Poly(2,2,3,3-tetrafluoropropyl methacrylate)	1.417†	68†	59,163-7	59,121-1 59,099-1	37,199-8
Poly(2,2,2-trifluoroethyl methacrylate)	1.418†	69†	59,196-3	59,175-0 59,186-6	37,376-1

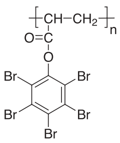
¥ Brandrup, J., et al. Polymer Handbook, 4th ed., John Wiley & Sons: New York, 1999; Aldrich Catalog No. **Z41,247-3**. † Gaynor, J. et al. *J. Appl. Polym. Sci.* **1993**, *50*, 1645.

High Refractive Index Materials

Homopolymers

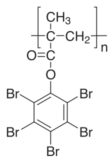
Poly(pentabromophenyl acrylate)

59,152-1 200mg, 1g



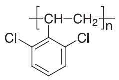
Poly(pentabromophenyl methacrylate)

59,206-4 200mg, 1g



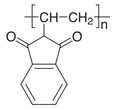
Poly(2,6-dichlorostyrene)

63,997-4 500mg



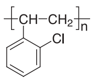
Poly(*N*-vinylphthalimide)

63,998-2 1g



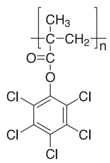
Poly(2-chlorostyrene)

64,001-8 1g



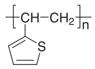
Poly(pentachlorophenyl methacrylate)

64,003-4 1g



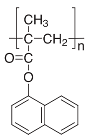
Poly(2-vinylthiophene)

64,018-2 1g



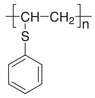
Poly(1-naphthylmethacrylate)

64,019-0 1g



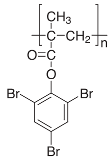
Poly(vinylphenylsulfide)

64,021-2 1g



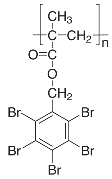
Poly(2,4,6-tribromophenyl methacrylate)

64,024-7 1g



Poly(pentabromobenzyl methacrylate)

64,030-1 500mg



Poly(pentabromobenzyl acrylate)

64,032-8 500mg

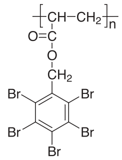
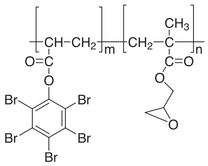


Photo-Crosslinkable Polymers

Poly(pentabromophenyl acrylate-*co*-glycidyl methacrylate)

59,150-5 200mg, 1g
50 mole% GMA

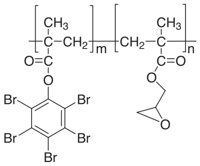
59,140-8 200mg, 1g
10 mole% GMA



Poly(pentabromophenyl methacrylate-*co*-glycidyl methacrylate)

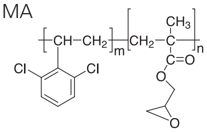
59,183-1 200mg, 1g
50 mole% GMA

59,161-0 200mg, 1g
10 mole% GMA



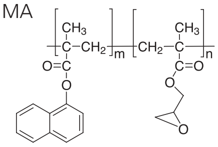
Poly(2,6-dichlorostyrene-*co*-glycidyl methacrylate)

64,017-4 500mg
10 mole% GMA



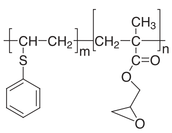
Poly(1-naphthylmethacrylate-*co*-glycidyl methacrylate)

64,020-4 500mg
10 mole% GMA



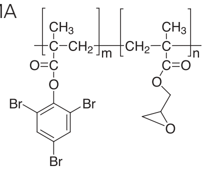
Poly(vinylphenylsulfide-*co*-glycidyl methacrylate)

64,022-0 500mg
10 mole% GMA



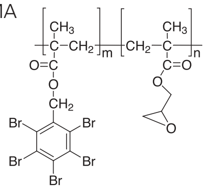
Poly(2,4,6-tribromophenyl methacrylate-*co*-glycidyl methacrylate)

64,025-5 500mg
10 mole% GMA



Poly(pentabromobenzyl methacrylate-*co*-glycidyl methacrylate)

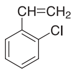
64,029-8 500mg
10 mole% GMA



Monomers

2-Chlorostyrene, 97%

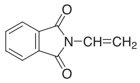
16,067-9



5g
25g

***N*-Vinylphthalimide**, 99%

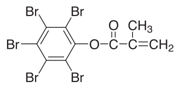
34,954-2



1g
5g

Pentabromophenyl methacrylate, 96%

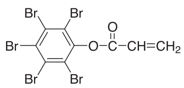
59,243-9



5g

Pentabromophenyl acrylate, 96%

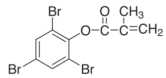
59,255-2



5g

2,4,6-tribromophenyl methacrylate

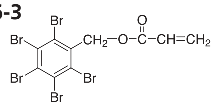
64,023-9



1g
5g

Pentabromobenzyl acrylate

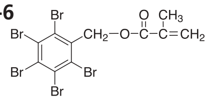
64,026-3



1g
5g

Pentabromobenzyl methacrylate

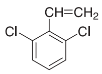
64,033-6



1g
5g

2,6-Dichlorostyrene, 99%

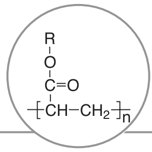
D7,450-9



2.5g
10g

Low Refractive Index Materials

Polyfluoroacrylates



Poly(2,2,2-trifluoroethyl acrylate)

63,009-8 R= $-CH_2CF_3$ 200mg 1g

Poly(2,2,3,3,3-pentafluoropropyl acrylate)

63,013-6 R= $-CH_2CF_2CF_3$ 200mg 1g

Poly(2,2,3,3-tetrafluoropropyl acrylate)

63,014-4 R= $-CH_2CF_2CHF_2$ 200mg 1g

Poly(1,1,1,3,3,3-hexafluoroisopropyl acrylate)

63,015-2 R= $-CH(CF_3)-CF_3$ 200mg 1g

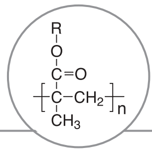
Poly(2,2,3,4,4,4-hexafluorobutyl acrylate)

63,016-0 R= $-CH_2CF_2CHFCF_3$ 200mg 1g

Poly(2,2,3,3,4,4,4-heptafluorobutyl acrylate)

63,017-9 R= $-CH_2CF_2CF_2CF_3$ 200mg 1g

Polyfluoromethacrylates



Poly(2,2,2-trifluoroethyl methacrylate)

59,196-3 R= $-CH_2CF_3$ 200mg 1g

Poly(2,2,3,3,3-pentafluoropropyl methacrylate)

59,208-0 R= $-CH_2CF_2CF_3$ 200mg 1g

Poly(2,2,3,3-tetrafluoropropyl methacrylate)

59,163-7 R= $-CH_2CF_2CHF_2$ 200mg 1g

Poly(1,1,1,3,3,3-hexafluoroisopropyl methacrylate)

59,132-7 R= $-CH(CF_3)-CF_3$ 200mg 1g

Poly(2,2,3,4,4,4-hexafluorobutyl methacrylate)

59,164-5 R= $-CH_2CF_2CHFCF_3$ 200mg 1g

Poly(2,2,3,3,4,4,4-heptafluorobutyl methacrylate)

59,197-1 R= $-CH_2CF_2CF_2CF_3$ 200mg 1g

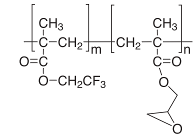
For additional low refractive index fluoropolymers that are amorphous, please refer to the Aldrich Materials Science catalog. Visit www.sigma-aldrich.com/matsci to request your free copy.

Photo-Crosslinkable Polymers

Poly(2,2,2-trifluoroethyl methacrylate-*co*-glycidyl methacrylate)

59,175-0 200mg, 1g
50 mole% GMA

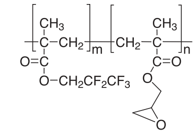
59,186-6 200mg, 1g
10 mole% GMA



Poly(2,2,3,3,3-pentafluoropropyl methacrylate-*co*-glycidyl methacrylate)

59,089-4 200mg, 1g
50 mole% GMA

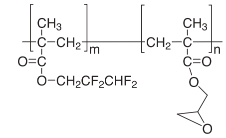
59,110-6 200mg, 1g
10 mole% GMA



Poly(2,2,3,3-tetrafluoropropyl methacrylate-*co*-glycidyl methacrylate)

59,121-1 200mg, 1g
50 mole% GMA

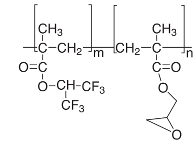
59,099-1 200mg, 1g
10 mole% GMA



Poly(1,1,1,3,3,3-hexafluoroisopropyl methacrylate-*co*-glycidyl methacrylate)

59,154-8 200mg, 1g
50 mole% GMA

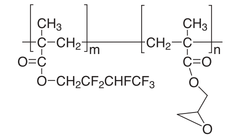
59,143-2 200mg, 1g
10 mole% GMA



Poly(2,2,3,4,4,4-hexafluorobutyl methacrylate-*co*-glycidyl methacrylate)

59,187-4 200mg, 1g
50 mole% GMA

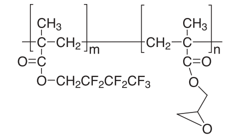
59,176-9 200mg, 1g
10 mole% GMA



Poly(2,2,3,3,4,4,4-heptafluorobutyl methacrylate-*co*-glycidyl methacrylate)

59,210-2 200mg, 1g
50 mole% GMA

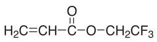
59,209-9 200mg, 1g
10 mole% GMA



Monomers

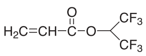
2,2,2-Trifluoroethyl acrylate, 99%

29,772-0 5g, 25g



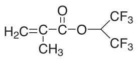
1,1,1,3,3,3-Hexafluoroisopropyl acrylate, 99%

36,765-6 1g, 5g



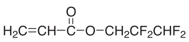
1,1,1,3,3,3-Hexafluoroisopropyl methacrylate, 99%

36,766-4 1g, 5g



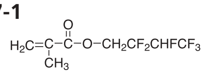
2,2,3,3-Tetrafluoropropyl acrylate, 96%

37,192-0 5g



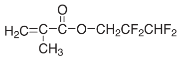
2,2,3,4,4,4-Hexafluorobutyl methacrylate, 98%

37,197-1 5g, 25g



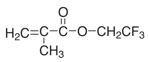
2,2,3,3-Tetrafluoropropyl methacrylate, 99%

37,199-8 5g, 25g



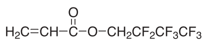
2,2,2-Trifluoroethyl methacrylate, 99%

37,376-1 5g, 25g



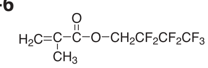
2,2,3,3,4,4,4-heptafluorobutyl acrylate, 97%

44,375-1 5mL, 25mL



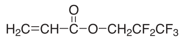
2,2,3,3,4,4,4-heptafluorobutyl methacrylate, 97%

44,400-6 1g, 5g



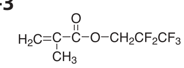
2,2,3,3,3-Pentafluoropropyl acrylate, 98%

47,096-1 5mL, 25mL



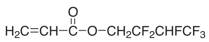
2,2,3,3,3-Pentafluoropropyl methacrylate, 97%

47,419-3 5mL, 25mL



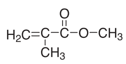
2,2,3,4,4,4-Hexafluorobutyl acrylate, 95%

47,445-2 5mL, 25mL



Methyl methacrylate, 99%

M5,590-9 25mL, 500mL, 1L



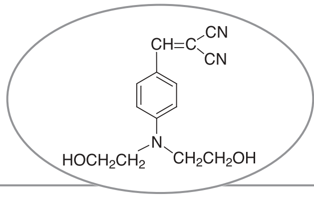
NLO (Nonlinear Optical) Polymers

Organic NLO materials are often superior to inorganics in terms of their response speeds and the magnitude of their third-order effect.[4,5,6] Polymeric NLO materials offer several advantages over small-molecule NLOs including optical clarity and large dielectric susceptibility. Also NLO-active moieties on the polymers can be oriented within an electric field leading to an enhancement in the electro-optic coefficient.[7]

For a material to exhibit nonlinear optical (NLO) activity it should be noncentrosymmetric. In polymer-based NLO materials, the chromophore can be incorporated into a polymer matrix in a number of ways. Early efforts focused on guest–host systems. Alternatively, the chromophores were covalently attached to the polymer backbone as side chains, or made part of the polymer backbone itself, markedly improving long–term stability, and permitting their use in practical devices.[3,8]

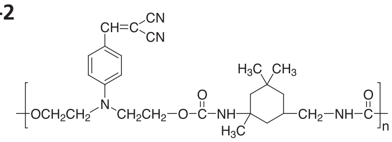
Aldrich offers a wide range of NLO materials, including chromophores, intermediates, NLO monomers and NLO polymers. The newest additions are shown below. A complete selection is provided in the Photonics/Optical Materials section of the Aldrich Materials Science catalog. A free copy is available by request only at www.sigma-aldrich.com/matsci.

4-(2,2-Dicyanovinyl)-*N*-bis(hydroxyethyl) aniline based NLO Polymers



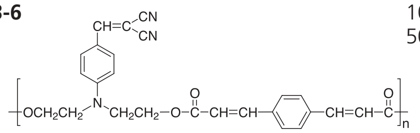
Poly(4-(2,2-dicyanovinyl)-*N*-bis(hydroxyethyl) aniline-*alt*-(isophoronediisocyanate))urethane

63,225-2 — 100mg, 500mg



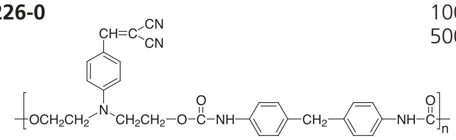
Poly(4-(2,2-dicyanovinyl)-*N*-bis(hydroxyethyl) aniline-*alt*-*p*-phenylenediacrylate), 95%

63,223-6 — 100mg, 500mg



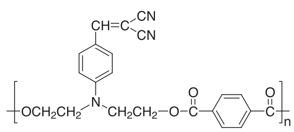
Poly(4-(2,2-dicyanovinyl)-*N*-bis(hydroxyethyl) aniline-*alt*-(4,4'-methylenebis(phenyl isocyanate)))urethane

63,226-0 — 100mg, 500mg

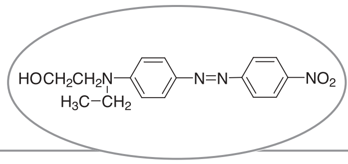


Poly(4-(2,2-dicyanovinyl)-*N*-bis(hydroxyethyl) aniline-*alt*-terephthalate)

63,224-4 — 100mg, 500mg

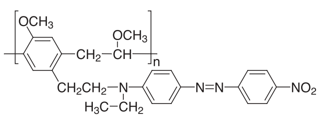


Disperse red 1 based NLO Polymers



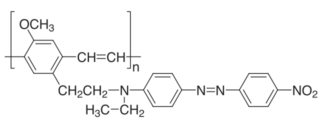
Poly[(1-methoxy-4-(*O*-disperse red 1)-2,5-bis(2-methoxyethyl)benzene)]

63,034-9 — 100mg, 500mg



Poly[(1-methoxy-4-(*O*-disperse red 1))-2,5-phenylenevinylene]

63,032-2 — 100mg, 500mg

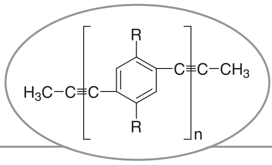


Photoluminescent Conjugated Polymers: Poly(phenylene ethynylene) or PPE

Aldrich offers a wide range of conjugated polymers from several polymer classes, including polyacetylene, polyaniline, polypyrrole, polythiophene, poly(phenylene vinylene) (PPV), polyfluorene (PFO), and poly(fluorenylene vinylene) (PFE). Our latest additions are in the poly(phenylene ethynylene) (PPE) class. PPE, an acetylene analog of poly(phenylene vinylene) (PPV), has recently seen increased interest for use in electroluminescent devices. With its conjugated rigid-rod-like character and excellent optical/electrical properties, this conjugated polymer has seen use as light emitting diodes, plastic lasers, light-emitting electrochemical cells (LECs), and polarizers in LC displays. Various alkyl substituents further result in improved solubility characteristics, in organic solvents, and processability.[9]

PPE monomers are available to facilitate your copolymer synthesis. Aldrich also offers a wide selection of charge-transport materials to assist you in the manufacture of multilayer LEDs using light-emitting polymers. These are included in the newly released Materials Science Catalog. Request your free copy at www.sigma-aldrich.com/matsci.

PPE Derivatives



Poly(2,5-dioctylphenylene-1,4-ethynylene)

63,699-1 500mg

R= $-CH_2(CH_2)_6CH_3$

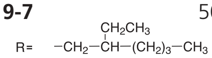
Poly(2,5-didodecylphenylene-1,4-ethynylene)

63,700-9 500mg

R= $-CH_2(CH_2)_{10}CH_3$

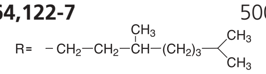
Poly(2,5-di(2'-ethylhexyl)phenylene-1,4-ethynylene)

64,119-7 500mg



Poly(2,5-di(3',7'-dimethyloctyl)-phenylene-1,4-ethynylene)

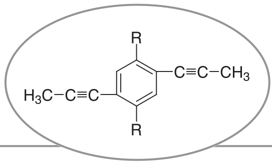
64,122-7 500mg



Poly(2,5-dicyclohexylphenylene-1,4-ethynylene)

63,668-1 200mg, 1g

Monomers for PPE



2,5-dioctyl-1,4-di-1-propynylbenzene

63,697-5 500mg

R= $-CH_2(CH_2)_6CH_3$

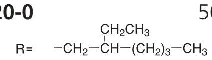
2,5-didodecyl-1,4-di-1-propynylbenzene

63,698-3 500mg

R= $-CH_2(CH_2)_{10}CH_3$

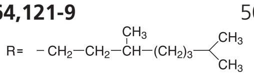
2,5-di(2'-ethylhexyl)-1,4-di-1-propynylbenzene, 98%

64,120-0 500mg



2,5-di(3',7'-dimethyloctyl)-1,4-di-1-propynylbenzene, 98%

64,121-9 500mg



2,5-dicyclohexyl-1,4-di-1-propynylbenzene

63,646-0 250mg, 1g

Light-Emitting Dopants/Fluorescent Dyes

Photoluminescent small molecules that are purely organic in composition are also referred to as light-emitting dopants or fluorescent dyes. These luminescent molecules have found wide ranging use depending on their emission wavelength. Fluorescent dyes are useful as optical quantum generators, solar radiation converters, and colorants for polymeric materials, among other applications.[10] Fluorescent dye-sensitized photoelectrochemical cells showed an enhanced photocurrent with remarkable stability.[11] Recent work has also shown the utility of optical, thin-film, polymeric sensors of aqueous halide ions based on fluorescence quenching.[12] These photoluminescent dyes have been utilized extensively as emissive dopants in organic and polymeric electroluminescent devices.[21]

Sigma-Aldrich has an extensive selection of light emitting dopants/fluorescent dyes. The recent additions are reported here along with characteristic absorption and emission wavelengths. For a comprehensive selection of these molecules, please refer to the Display/Photovoltaics section in the new Materials Science catalog.

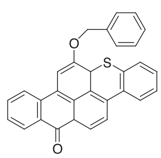
Catalog Number	Empirical Formula	Molecular Weight	mp (°C)	Absorption Range (nm)¥	Absorption λ_{max} (nm)¥	Emission Range (nm)¥	Emission λ_{max} (nm)¥
64,175-8	$C_{30}H_{19}O_2S$	443.55	243-247	450-650	541	560-750	587
64,176-6	$C_{30}H_{27}NO_2S$	465.62	196-198	450-650	—	560-750	607
64,177-4	$C_{38}H_{26}N_4O_2$	570.65	283-285	400-450	518	490-550	617
64,180-4	$C_{48}H_{34}N_2O_4S_2$	766.94	260-270	450-650	623	560-750	662
64,179-0	$C_{50}H_{48}O_4$	712.93	186-189	450-650	635	560-750	714
64,178-2	$C_{70}H_{84}O_6$	1021.43	176-180	450-650	580	560-750	635

¥ Solution in toluene.

Photoluminescent Small Molecules

Thioxanthone-64

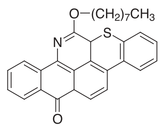
64,175-8



1g
5g

Thioxanthone-65

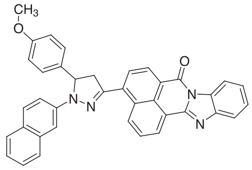
64,176-6



1g
5g

Pyrazole-72

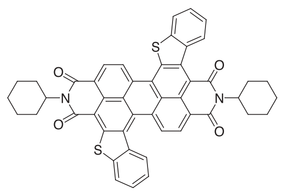
64,177-4



1g
5g

Perylene-66

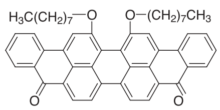
64,180-4



1g
5g

Violanthrone-79

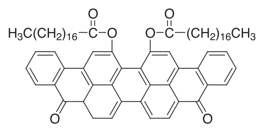
64,179-0



1g
5g

Violanthrone-78

64,178-2



1g
5g

FITC-Functionalized Polyelectrolytes for SAMs

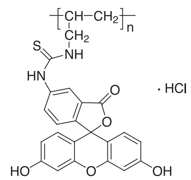
Polyelectrolytes are defined as materials for which the solution properties in solvents of high dielectric constant are governed by electrostatic interactions over distances larger than typical molecular dimensions.[13,14] These materials are widely used in industrial applications as dispersants in aqueous media, flocculating agents to coagulate slurries and industrial wastes, for sizing in textile and paper manufacture, and as conditioning additives to drilling muds and soil to prevent abrasive damage. More recently, they have been applied in electrostatic self-assembly techniques[22] for thin film deposition of electrically conducting polymers,[15] conjugated polymers for light emitting devices,[16] nanoparticles,[17] and nonlinear optical (NLO) materials.[18]

In addition to our existing selection of polyelectrolytes, Aldrich now offers the following new products. These materials are comprised of a poly(allylamine hydrochloride) backbones (Aldrich Catalog No. **28,322-3** and **28,321-5**) labeled with fluorescein isothiocyanate (FITC).

Cationic Polyelectrolytes

Poly(fluorescein isothiocyanate allylamine hydrochloride)

63,020-9 70K base polymer M_w	250mg
63,021-7 15K base polymer M_w	250mg

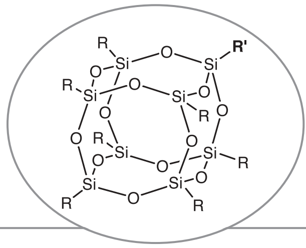


Polyhedral Silsesquioxanes (PSS)

Polysilsesquioxanes have generated a great deal of interest because of their potential replacement for and compatibility with currently employed, silicon-based inorganics in the electronics, photonics, and other materials technologies.[19,20]

Many of these silsesquioxane hybrid materials also exhibit an enhancement in properties such as solubility, thermal and thermomechanical stability, mechanical toughness, optical transparency, gas permeability, dielectric constant, and fire retardancy, to name just a few.

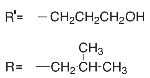
In addition to the new silsesquioxanes listed below, Aldrich currently offers an excellent selection of completely and incompletely condensed silsesquioxane frameworks as well as precursors and intermediates. Additional information is available by requesting Sigma-Aldrich's ChemFile Vol. 1, No. 6, **2001**, *Silsesquioxanes, Bridging the Gap between Polymers & Ceramics* (literature code: ELP).



Silsesquioxanes

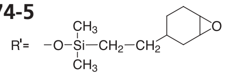
PSS-(3-hydroxypropyl)-Heptaisobutyl substituted, R≠R'

63,792-0 — 1g, 5g



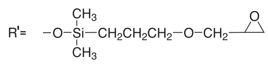
PSS-Octa((1,2-epoxy-4-ethylcyclohexyl)-dimethyl siloxy) substituted, R=R'

59,374-5 — 1g, 5g



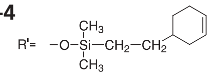
PSS-Octa((3-propylglycidylether)-dimethyl siloxy) substituted, R=R'

59,386-9 — 1g, 5g



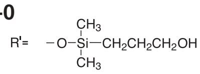
PSS-Octa(2(4-cyclohexenyl)ethyl-dimethyl silyloxy) substituted, R=R'

59,397-4 — 1g, 5g



PSS-Octa((3-hydroxypropyl)-dimethylsiloxy) substituted, R=R'

59,418-0 — 1g, 5g



References

(1) (a) Beecroft, L.L., Ober, C.K., *J.M.S.-Pure Appl. Chem.*, **1997**, *A34(4)*, pp. 573. (b) *Polymer Optic Fibers*, Nalwa, H.S., Ed.; American Scientific Publishers, **2003**; Aldrich Catalog No. **Z55,215-1**. (2) Pitois, C. et al. *Macromolecules*, **1999**, *32*, 2903. (3) Prasad, P., Williams, D., *Introduction To Nonlinear Optical Effects In Molecules & Polymers*, John Wiley & Sons, **1991**; Aldrich Catalog No. **Z22,382-4**. (4) Tripathy, S. et al. *Chemtech* **1989**, *19*, 620, (5) Tripathy, S. et al. *ibid.* **1989**, *19*, 747. (6) Chang, T. Y. *Optical Engineering* **1981**, *20*, 220. (7) Ambrosanio, P. et al. *Polymer* **1999**, *40*, 4923. (8) *Nonlinear Optics of Organic Molecules and Polymers*, Nalwa, H.S.; Miyata, S., Eds.; American Scientific Publishers, **1996**; Aldrich Catalog No. **Z55,222-4**. (9) Huang, W.Y. et al. *Macromolecules* **2001**, *34*, 1570, *and references therein*. (10) Ferrillo, R. G. et al. *Thermochim. Acta* **1982**, *54(3)*, 309. (11) Fernando, C.A.N. et al. *Sol. Energy Mater., Sol. Cells* **2001**, *69*, 345. (12) Geddes, C.D. *Dyes Pigments* **2000**, *45*, 243. (13) *Specialty Polymers*; Dyson, R.W., Ed.; Chapman and Hall, **1987**; p 110; Aldrich Catalog No. **Z22,414-6**. (14) For a discussion of the differences between polyelectrolytes and ionomers, see: Eisenberg, A.; Kim, J-S. *Introduction to Ionomers*; John Wiley, **1998**; Aldrich Catalog No. **Z41,033-0**. (15) Sayre, C.N.; Collard, D.M. *J. Mater. Chem*. **1997**, *7*, 909. (16) Cheung, J. et al. *Polym. Prepr*. **1993**, *34*, 757. (17) Schmitt, J. et al. *Adv. Mater*. **1997**, *9*, 61. (18) Wang, X. et al. *Macromol. Rapid Commun*. **1997**, *18*, 451. (19) Baney, R.H. et al. *Chem Rev.* **1995**, *95*, 1409. (20) Lichtenhan, J.D. Silsesquioxane-Based Polymers in *The Polymeric Materials Encyclopedia: Synthesis, Properties and Applications*; Salamone, J.C., Ed.; CRC Press, **1996**; Aldrich Catalog No. **Z42,237-1**. (21) *Handbook of Luminescence, Display Materials, and Devices, 3 Volumes*, Nalwa, H.S., Rohwer, L.S., Eds.; American Scientific Publishers, **2003**; Aldrich Catalog No. **Z54,768-9**. (22) *Handbook of Polyelectrolytes and Their Applications, 3 Volumes*, Tripathy, S. et al., Eds.; American Scientific Publishers, **2002**; Aldrich Catalog No. **Z54,718-2**.

SPIN-COATING SYSTEM

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 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.

Dispenser, Spin-Coater, Hot Plate, and UV Curer shown above.

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. CE compliant.

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. Contains internal thermocouple and has digital control features. CE compliant.

Specifications:
- Plate dim.: 6 x 6in.
- Temp. Resolution: 1°C
- Temp. Range: 120–660°F

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

UV Curer & Dispenser

UV Curer: 2 tubes included.
Dim.: 8 ¼ x 9 ½ in. CE compliant.

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.
CE compliant.

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

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

UV Curer shown above.

See Technical Bulletin AL-214 for additional parts and information, available at www.sigma-aldrich.com/aldrich.

For technical assistance or applications questions, please contact us at 800-231-8327 (USA) or 414-273-3850 (international).

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- ❑ CD-ROM
- ❑ Information on Web site with a notification via email

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- ❑ Materials Research Bulletin
- ❑ Materials Today
- ❑ Optical Materials
- ❑ Photonics Spectra
- ❑ Physics Today
- ❑ Other ____________________

3. Areas of Interest (Please check all that apply).

- ❑ Conducting Polymers (CONP)
- ❑ Display (DISP)
- ❑ Materials Science (MAMI)
- ❑ Microelectronics (MIEL)
- ❑ Nonlinear Optical Materials (NLO)
- ❑ Photonic/Optical Materials (OPOP)
- ❑ Polymers (POLY)
- ❑ Other ____________________

4. FREE Aldrich Catalog/Technical Literature (Please check all that apply).

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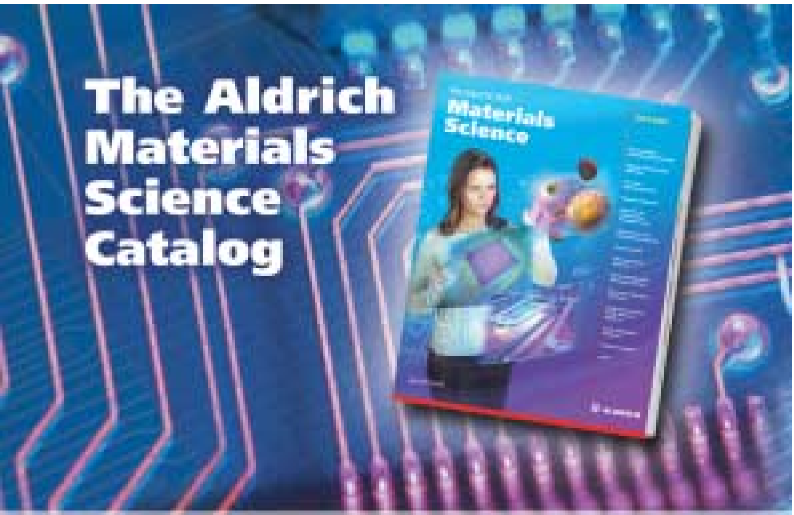

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Books for Reading & Reference

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Nonlinear Optics of Organic Molecules and Polymers

Hari Singh Nalwa, Seizo Miyata, eds., American Scientific Publishers, 1996, 896pp., Hard cover.

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Handbook of Luminescence, Display Materials, and Devices, 3 Volumes

Hari Singh Nalwa and Lauren Shea Rohwer, eds., American Scientific Publishers, 2003, 1200pp., Hard cover.

This is an essential resource that provides a comprehensive look at organic and inorganic luminescent materials such as organic light emitting diodes, and inorganic display materials. Chemists, researchers, and graduate students working with luminescent materials, polymer science, optical engineering and related fields will find these to be a helpful reference tool.

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Polymer Optical Fibers

Hari Singh Nalwa, ed., American Scietific Publishers, 2003, 200pp., Hard cover.

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Handbook of Polyelectrolytes and Their Applications, 3 Volumes

Sukant Tripathy, Jayant Kumar, and Hari Singh Nalwa, eds., American Scientific Publishers, 2002, 1200pp., Hard cover.

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