MATERIALS

Liquid Crystal Materials

Nematic & Smectic Liquid Crystals

Cholesteric Liquid Crystals

Discotic Liquid Crystals

Liquid Crystal Materials

Liquid crystals are states (or compounds) having both fluidity like liquids and long range order like crystals. To be specific, liquid crystalline states involve an ordered molecular orientation but they partially or fully lack positional orders of gravity center in the arranged molecules compared to normal crystal states. Thermotropic and lyotropic liquid crystals are two main classes of liquid crystals. The former liquid crystalline phase appears by changing temperature, and the latter phase appears by changing solution concentration of amphiphilic compounds, etc.

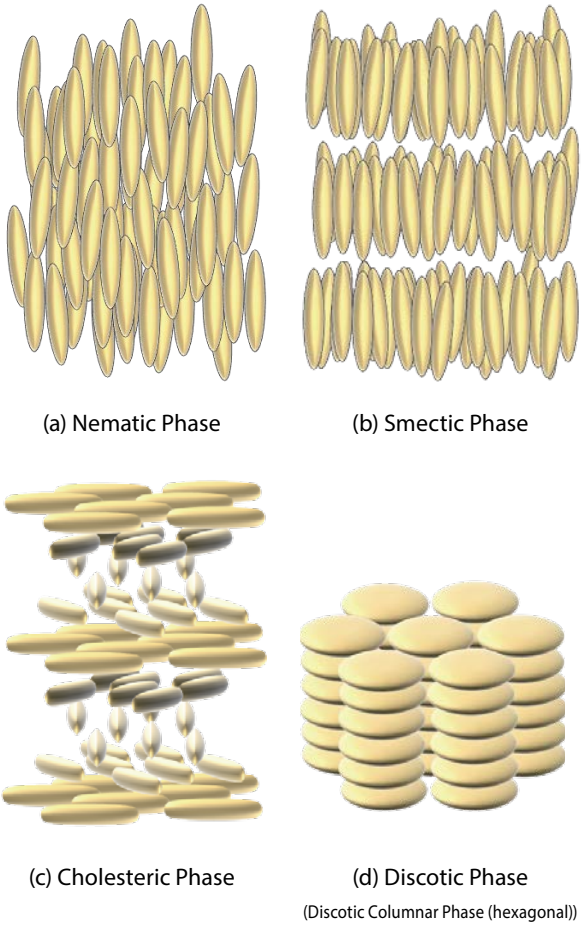
Most thermotropic liquid crystalline molecules have either a calamitic or discotic molecular shape. Calamitic liquid crystals usually exhibit several mesophases: nematic, smectic, and cholesteric phases. Forming these liquid crystalline states enables these compounds to exhibit characteristic functions such as optical anisotropy and ferroelectricity. Besides calamitic and discotic liquid crystals, other liquid crystals with unique molecular shapes e.g. banana-shaped ones with bent-cores[1,2] and shuttlecock-shaped fullerene derivatives[3] have been investigated extensively.

The nematic phase is a state in which molecules are oriented along the direction of the molecular long axis but the molecular gravity centers are randomly located like an isotropic liquid (Fig. 1(a)). A nematic phase usually appears at a higher temperature than the other mesophases when there are several possible ones. The TN (Twisted Nematic) mode[4] of liquid crystal displays requires fast responding nematic liquid crystal molecules having large dielectric constant anisotropy, e.g. 5CB (4-Cyano-4'-pentyl-biphenyl).

The smectic phases show a positionally ordered molecular arrangement with organization along the molecular long axis as well as with layered organizations shown in Fig. 1(b). These phases appear at the lower temperature range with lower fluidity than those of nematic phases. Smectic phases are diverse due to a distinct molecular arrangement in the layers and distinct orders of inter- and intra- layers.

The cholesteric phase shown in Fig. 1(c) usually involves cholesteryl compounds. On the basis of chirality of the molecules, the phase demonstrates twisted molecular arrangements, resulting in helical structures with certain periodicity (pitch). The phase may be categorized into nematic phases and called a chiral nematic phase. An addition of chiral inducers into nematic liquid crystals also provides the cholesteric phase. Since the helical pitch is thermally responsive to changing reflective colors, they are applicable for liquid crystal thermometers.

The discotic phases, the state composed by disk-like molecules (Fig. 1(d)), are divided into more specific ones such as discotic nematic and discotic columnar types according to the molecular arrangements. It is a relatively new liquid crystalline phase initially found in 1977.[5]



(a) Nematic Phase (b) Smectic Phase

(c) Cholesteric Phase (d) Discotic Phase

(Discotic Columnar Phase (hexagonal))

Fig. 1 Illustration of typical liquid crystal phases

● Liquid Crystalline Phases with Complex 3D Structures

Some mesophases with complex 3D molecular arrangements also have been discovered. One representative example is the blue phase, which is expected to be a powerful candidate for fast response displays without an oriented film and a polarizer[6,7] and to be photonic crystals for laser oscillations.[8,9] Since the blue phases involve basic units, the so-called double-twist cylinders, all recognized phases, i.e., body centered cubic (Blue Phase I), simple cubic (Blue Phase II), and amorphous (Blue phase III) are optically isotropic. They are normally observed within a small temperature range (typically ~1 ºC) between cholesteric and isotropic phases. This fact has caused limitations on their application. In recent years, several research groups reported active examples e.g. extension of temperature range up to ~60 ºC by forming polymers in the blue phase (polymer-stabilized blue phase)[10] and up to ~40 ºC by developing two biphenyl-linked compounds.[11]

Polymer Dispersed Liquid Crystals

Polymer dispersed liquid crystals (PDLC) are applied to "smart windows" which can switch the transparency of windows by turning voltage on and off. In the PDLC films, liquid crystal domains are dispersed into the polymer matrix. Turning the voltage on can make the film transparent, because the refractive index of the liquid crystal domains becomes almost similar to that of the polymer matrix with respect to incident light by making liquid crystalline molecules align with the electric field. On the other hand, turning the voltage off makes the film translucent, because the refractive index of the liquid crystal becomes different from that of the matrix by forming a random location of the liquid crystalline molecules. In addition to the smart windows, the PDLCs are also expected to be used as materials for reflective displays working with low power such as an electronic paper.

Liquid Crystalline Semiconductors

There are many organic semiconductors having liquid crystallinity. Liquid crystalline semiconductors have provided much interest for enabling production of devices in a wet process at low cost, improvement of molecular orientation and carrier mobility utilizing their self-organizing ability in a post-process, and fabrication of flexible devices with high bending strength more than crystalline organic semiconductors. In addition to calamitic liquid crystalline semiconductors,[12] discotic ones have been developed.[13] The discotic liquid crystalline semiconductors demonstrate efficient carrier mobility along with the columnar direction of the stacked molecules, therefore, they can be used as materials for organic photovoltaics (OPVs).[14]

Applications of Liquid Crystal Media for Providing Functions

Liquid crystals are also utilized as reaction media for providing some specific functions to other materials. A few decades ago, acetylene was polymerized in liquid crystal solvents to control the orientation of the polymer-aggregated fibril structure enhancing electrical conductivity to the oriented direction.[15] Other examples for such studies are synthesis of mesoporous silica in the reaction media composed of lyotropic liquid crystals[16] and realization of oriented carbon nanotubes in liquid crystal media.[17]

References

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Nematic / Smectic Liquid Crystals

Cyanobiphenyls & Analogs

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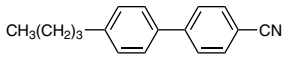

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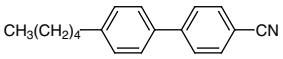

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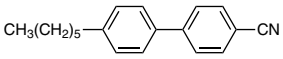

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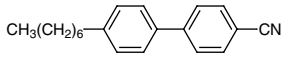

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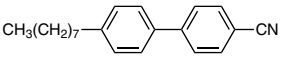

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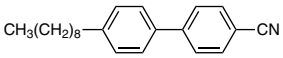

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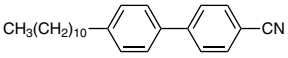

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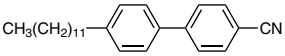

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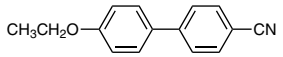

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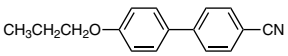

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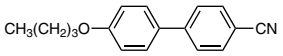

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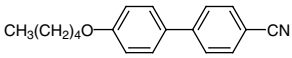

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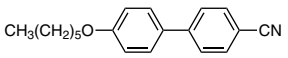

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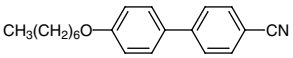

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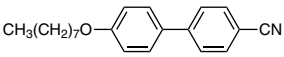

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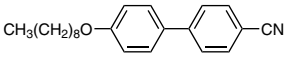

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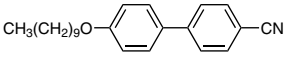

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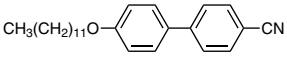

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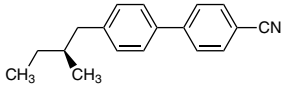

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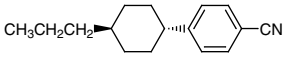

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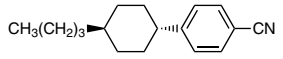

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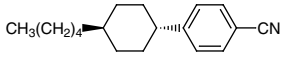

4-(*trans*-4-Amylcyclohexyl)benzonitrile

CAS RN: 61204-01-1

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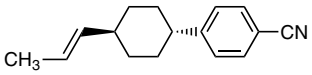
P2378 1g 5g



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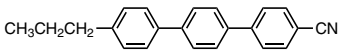

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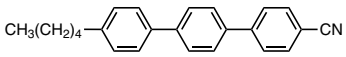

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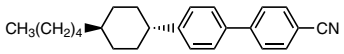

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Fluorinated Biphenyls & Analogs

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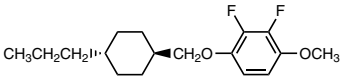

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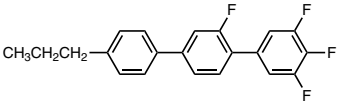

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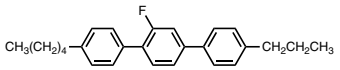

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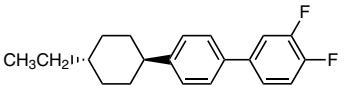

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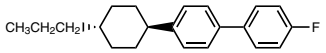

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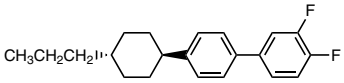

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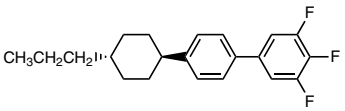

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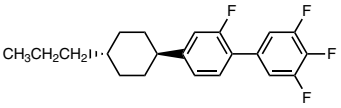

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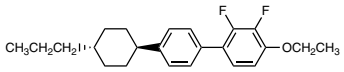

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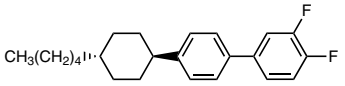

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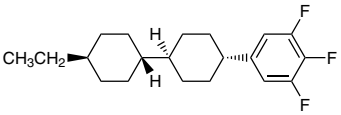
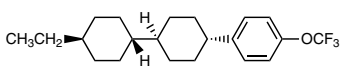
CAS RN: 134412-17-2

E1156 5g 25g



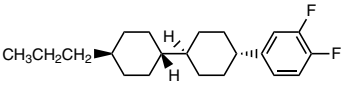
trans,trans-4'-Ethyl-4-(3,4,5-trifluorophenyl)bicyclohexyl
CAS RN: 139215-80-8

E1165 5g



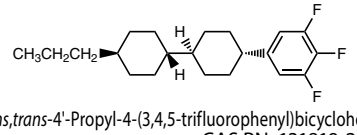
trans,trans-4'-Ethyl-4-(4-trifluoromethoxyphenyl)bicyclohexyl
CAS RN: 135734-59-7

D4797 1g 5g



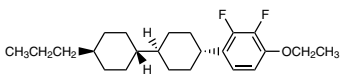
trans,trans-4-(3,4-Difluorophenyl)-4'-propylbicyclohexyl
CAS RN: 82832-57-3

P2314 5g 25g



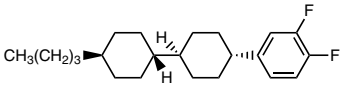
trans,trans-4'-Propyl-4-(3,4,5-trifluorophenyl)bicyclohexyl
CAS RN: 131819-23-3

E1157 1g 5g



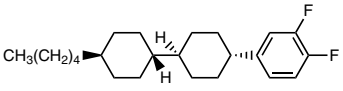
trans,trans-4-(4-Ethoxy-2,3-difluorophenyl)-4'-propylbicyclohexyl
CAS RN: 123560-48-5

B4925 5g 25g



trans,trans-4'-Butyl-4-(3,4-difluorophenyl)bicyclohexyl
CAS RN: 82832-58-4

D4798 1g 5g



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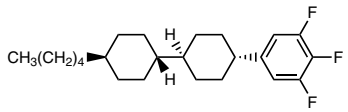
CAS RN: 118164-51-5

P2319 5g



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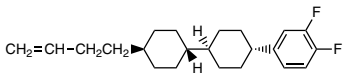
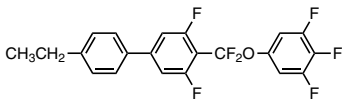
CAS RN: 137644-54-3

B4916 1g 5g



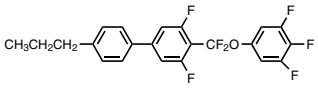
trans,trans-4'-(3-Butenyl)-4-(3,4-difluorophenyl)bicyclohexyl
CAS RN: 155266-68-5

D5129 1g 5g



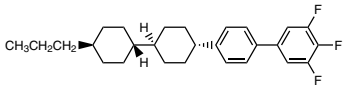
4-[Difluoro(3,4,5-trifluorophenoxy)methyl]-4'-ethyl-3,5-difluorobiphenyl
CAS RN: 303186-19-8

D5130 1g 5g



4-[Difluoro(3,4,5-trifluorophenoxy)methyl]-3,5-difluoro-4'-propylbiphenyl
CAS RN: 303186-20-1

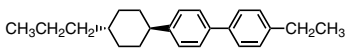
T3319 1g 5g



trans,trans-3,4,5-Trifluoro-4'-(4'-propylbicyclohexyl-4-yl)biphenyl
CAS RN: 137529-41-0

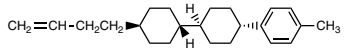
Other Biphenyls & Analogs

E1162 5g 25g



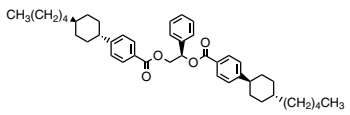
4-Ethyl-4'-(*trans*-4-propylcyclohexyl)biphenyl
CAS RN: 84540-37-4

B4915 1g 5g



trans,trans-4'-(3-Butenyl)-4-(*p*-tolyl)bicyclohexyl
CAS RN: 129738-42-7

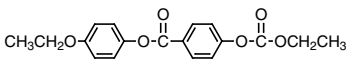
P2150 200mg 1g



(*R*)-1-Phenyl-1,2-ethanediyl Bis[4-(*trans*-4-pentylcyclohexyl)benzoate]
CAS RN: 154102-21-3

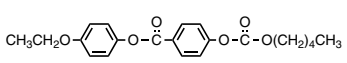
Carbonates

E0257 1g



4-(4-Ethoxyphenoxycarbonyl)phenyl Ethyl Carbonate
CAS RN: 33926-25-9

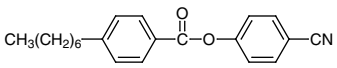
A0608 1g



Amyl 4-(4-Ethoxyphenoxycarbonyl)phenyl Carbonate
CAS RN: 33926-46-4

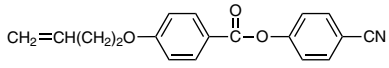
Phenyl Esters

H0810 1g 5g



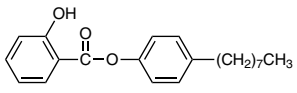
4-Cyanophenyl 4-Heptylbenzoate
CAS RN: 38690-76-5

B1586 1g



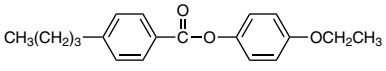
4-Cyanophenyl 4-(3-Butenyloxy)benzoate
CAS RN: 114482-57-4

S0016 25g



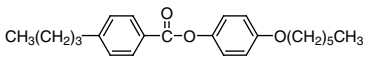
4-Octylphenyl Salicylate
CAS RN: 2512-56-3

B0375 1g



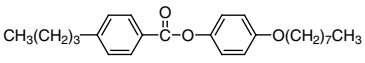
4-Ethoxyphenyl 4-Butylbenzoate
CAS RN: 62716-65-8

B1091 1g



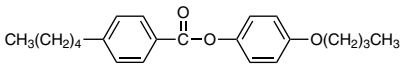
4-(Hexyloxy)phenyl 4-Butylbenzoate
CAS RN: 38454-28-3

B1092 1g



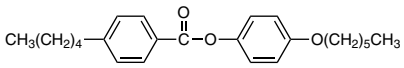
4-*n*-Octyloxyphenyl 4-Butylbenzoate
CAS RN: 42815-59-8

P0896 1g



4-Butoxyphenyl 4-Pentylbenzoate
CAS RN: 51128-24-6

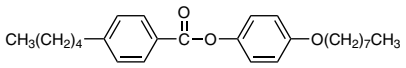
P0897 1g



4-Hexyloxyphenyl 4-Pentylbenzoate
CAS RN: 50802-52-3

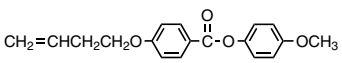
Please inquire for pricing and availability of listed products to our local sales representatives.

P0898 5g



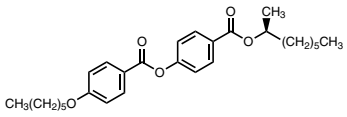
4-*n*-Octyloxyphenyl 4-Pentylbenzoate
CAS RN: 50649-64-4

M2106 1g 5g



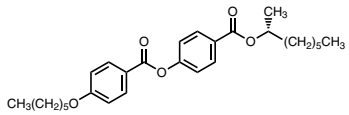
4-Methoxyphenyl 4-(3-Butenyloxy)benzoate
CAS RN: 76487-56-4

O0461 1g 5g



(*S*)-2-Octyl 4-[4-(Hexyloxy)benzoyloxy]benzoate
CAS RN: 87321-20-8

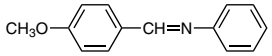
O0460 1g



(*R*)-2-Octyl 4-[4-(Hexyloxy)benzoyloxy]benzoate
CAS RN: 133676-09-2

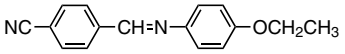
Schiff Bases

M0582 5g 25g



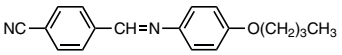
N-(4-Methoxybenzylidene)aniline
CAS RN: 836-41-9

C0744 1g



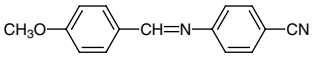
4'-Cyanobenzylidene-4-ethoxyaniline
CAS RN: 34128-02-4

C0743 1g



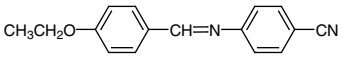
4'-Cyanobenzylidene-4-butoxyaniline
CAS RN: 55873-21-7

M0604 1g



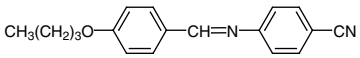
4-[(4-Methoxybenzylidene)amino]benzonitrile
CAS RN: 13036-19-6

E0240 1g



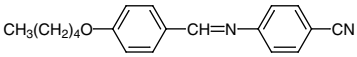
4'-Ethoxybenzylidene-4-cyanoaniline
CAS RN: 24742-30-1

B0252 1g



4'-Butoxybenzylidene-4-cyanoaniline
CAS RN: 36405-17-1

B0253 1g



4'-(Amyloxy)benzylidene-4-cyanoaniline
CAS RN: 37075-25-5

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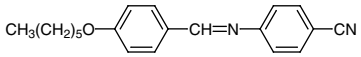
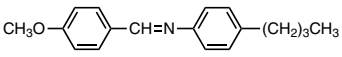


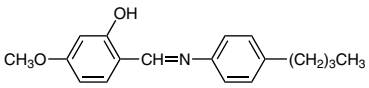
4'-Hexyloxybenzylidene-4-cyanoaniline
CAS RN: 35280-78-5

M0275 25g



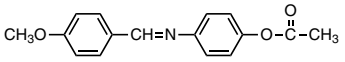
N-(4-Methoxybenzylidene)-4-butylaniline
CAS RN: 26227-73-6

B0250 1g



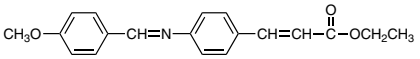
N-(4-Methoxy-2-hydroxybenzylidene)-4-butylaniline
CAS RN: 30633-94-4

M0581 25g



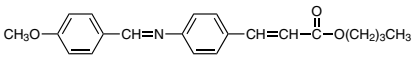
N-(4-Methoxybenzylidene)-4-acetoxyaniline
CAS RN: 10484-13-6

M0602 1g



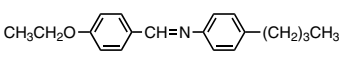
Ethyl 4-[(4-Methoxybenzylidene)amino]cinnamate
CAS RN: 6421-30-3

B0255 1g



Butyl 4-[(4-Methoxybenzylidene)amino]cinnamate
CAS RN: 16833-17-3

E0262 25g 500g



4'-Ethoxybenzylidene-4-butylaniline
CAS RN: 29743-08-6

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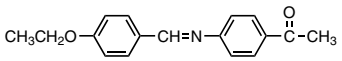
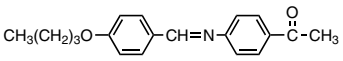


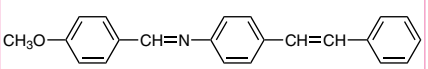
N-(4-Ethoxybenzylidene)-4-acetylaniline
CAS RN: 17224-17-8

B0372 1g



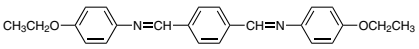
N-(4-Butoxybenzylidene)-4-acetylaniline
CAS RN: 17224-18-9

M0603 1g



4-[(Methoxybenzylidene)amino]stilbene
CAS RN: 322413-12-7

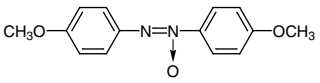
B0871 5g 25g



Terephthalbis(*p*-phenetidine)
CAS RN: 17696-60-5

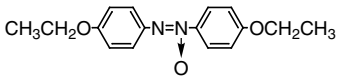
Azoxybenzenes

A0554 5g 25g



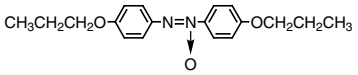
4,4'-Azoxydianisole
CAS RN: 1562-94-3

A0683 1g 5g



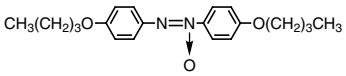
4,4'-Azoxydiphenetole
CAS RN: 4792-83-0

D1094 5g



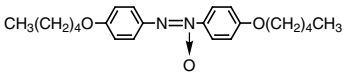
4,4'-Dipropoxyazoxybenzene
CAS RN: 23315-55-1

D1096 1g



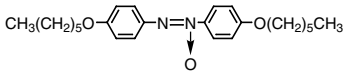
4,4'-Dibutoxyazoxybenzene
CAS RN: 17051-01-3

D1093 1g



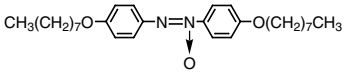
4,4'-Diamyloxyazoxybenzene
CAS RN: 19482-05-4

D1092 1g



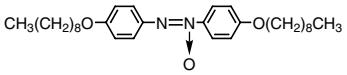
4,4'-Dihexyloxyazoxybenzene
CAS RN: 2587-42-0

D1123 1g 5g



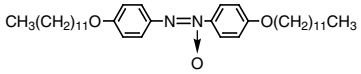
4,4'-Di-*n*-octyloxyazoxybenzene
CAS RN: 25729-12-8

D1518 100mg



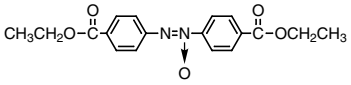
4,4'-Dinonyloxyazoxybenzene
CAS RN: 25729-13-9

D0553 5g



4,4'-Didodecyloxyazoxybenzene
CAS RN: 2312-14-3

A1065 1g

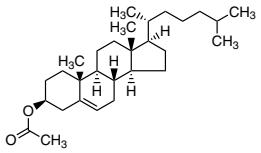


Diethyl Azoxybenzene-4,4'-dicarboxylate
CAS RN: 6421-04-1

Cholesteric Liquid Crystals

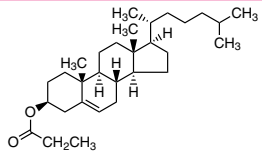
Cholesteryl Compounds

C0319 25g



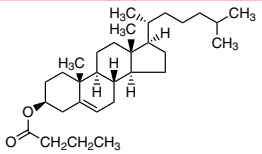
Cholesterol Acetate
CAS RN: 604-35-3

C0676 10g 25g



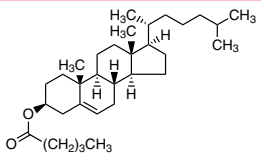
Cholesterol Propionate
CAS RN: 633-31-8

C0668 25g



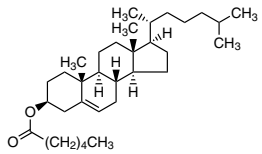
Cholesterol Butyrate
CAS RN: 521-13-1

C0677 10g



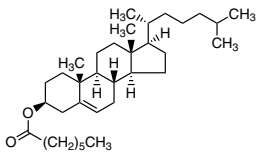
Cholesterol Valerate
CAS RN: 7726-03-6

C0673 25g



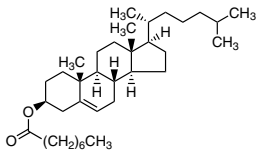
Cholesterol Hexanoate
CAS RN: 1062-96-0

C0672 25g



Cholesterol Heptanoate
CAS RN: 1182-07-6

C0334 5g 25g



Cholesterol *n*-Octanoate
CAS RN: 1182-42-9

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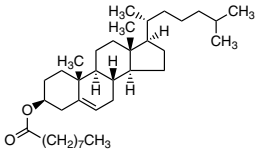
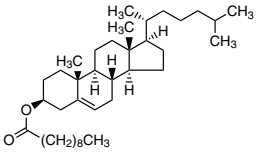
N0347 25g 500g



Cholesterol Pelargonate

CAS RN: 1182-66-7

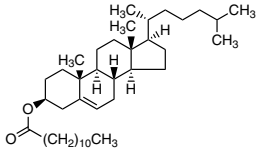
C0618 25g



Cholesterol Decanoate

CAS RN: 1183-04-6

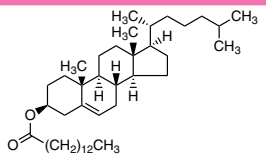
C0620 25g



Cholesterol Laurate

CAS RN: 1908-11-8

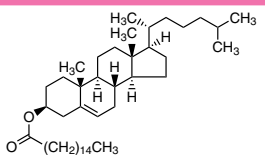
C0675 10g 25g



Cholesterol Myristate

CAS RN: 1989-52-2

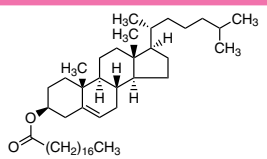
C0322 5g 25g



Cholesterol Palmitate

CAS RN: 601-34-3

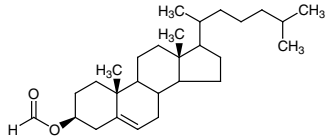
C0323 25g



Cholesterol Stearate

CAS RN: 35602-69-8

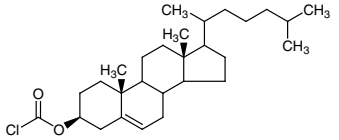
C0671 10g



Cholesterol Formate

CAS RN: 4351-55-7

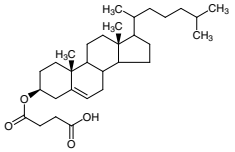
C0694 25g 100g



Cholesterol Chloroformate

CAS RN: 7144-08-3

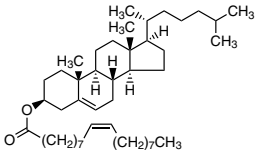
C0674 10g



Cholesterol Hydrogen Succinate

CAS RN: 1510-21-0

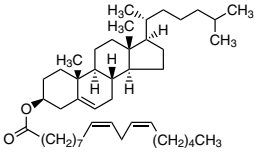
C0559 25g 100g 500g



Cholesterol Oleate

CAS RN: 303-43-5

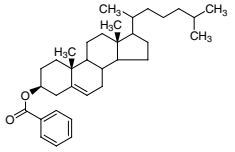
C0321 25g



Cholesterol Linoleate

CAS RN: 604-33-1

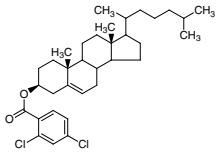
C0320 25g



Cholesterol Benzoate

CAS RN: 604-32-0

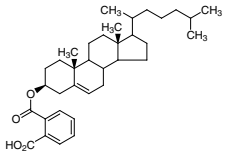
C1260 25g



Cholesterol 2,4-Dichlorobenzoate

CAS RN: 32832-01-2

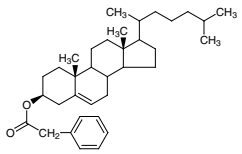
C0692 10g



Cholesterol Hydrogen Phthalate

CAS RN: 6732-01-0

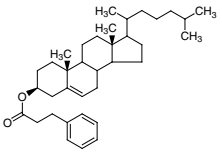
C0693 10g



Cholesterol Phenylacetate

CAS RN: 33998-26-4

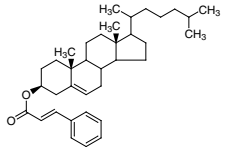
C0619 10g



Cholesterol Hydrocinnamate

CAS RN: 14914-99-9

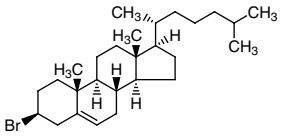
C0617 25g



Cholesterol *trans*-Cinnamate

CAS RN: 50305-81-2

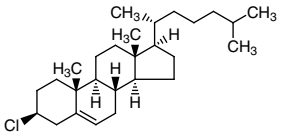
C0695 10g



Cholesteryl Bromide from Beef Fat

CAS RN: 516-91-6

C0610 25g

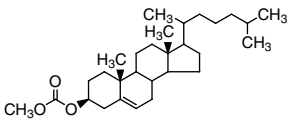


Cholesteryl Chloride

CAS RN: 910-31-6

Cholesteryl Carbonates

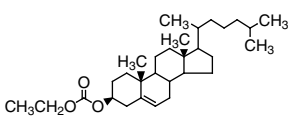
C0715 10g



Cholesterol Methyl Carbonate

CAS RN: 15507-52-5

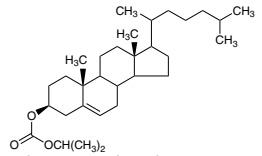
C0716 10g



Cholesterol Ethyl Carbonate

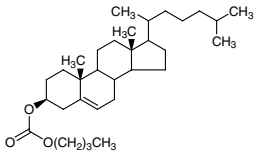
CAS RN: 23836-43-3

C0717 10g



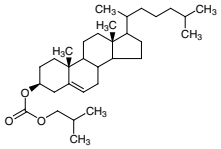
Cholesterol Isopropyl Carbonate
CAS RN: 78916-25-3

C0718 10g



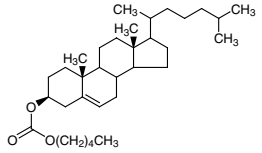
Cholesterol Butyl Carbonate
CAS RN: 41371-14-6

C0719 10g



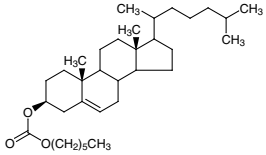
Cholesterol Isobutyl Carbonate
CAS RN: 77546-35-1

C0720 1g 10g



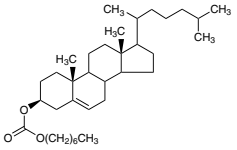
Cholesterol Amyl Carbonate
CAS RN: 15455-79-5

C0725 10g



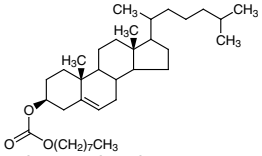
Cholesterol Hexyl Carbonate
CAS RN: 15455-80-8

B0264 10g



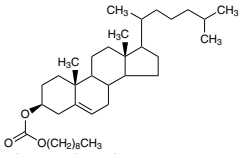
Cholesterol Heptyl Carbonate
CAS RN: 15455-81-9

C0721 10g



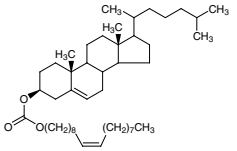
Cholesterol *n*-Octyl Carbonate
CAS RN: 15455-82-0

B0256 1g 10g



Cholesterol Nonyl Carbonate
CAS RN: 15455-83-1

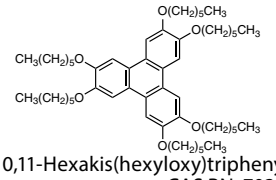
C0691 10g 25g



Cholesterol Oleyl Carbonate
CAS RN: 17110-51-9

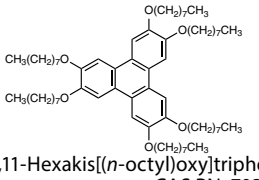
Discotic Liquid Crystals

H1449 200mg 1g



2,3,6,7,10,11-Hexakis(hexyloxy)triphenylene
CAS RN: 70351-86-9

H1450 200mg 1g



2,3,6,7,10,11-Hexakis[(*n*-octyl)oxy]triphenylene
CAS RN: 70351-87-0

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