

## ALD Materials

Atomic layer deposition (ALD) is a chemically self-limiting deposition technique that is based on the sequential use of a gaseous chemical process. In most cases, ALD reactions use two chemical precursors which react with a surface one at a time in a sequential, self-limiting, manner. A thin film results from repeating the deposition sequence as many times as needed to reach a certain thickness. The major characteristic of the films is their conformality and the fact that the amount of control provided by an ALD arrangement (where the reacting precursors are spatially separated) allows to obtain very thin deposited layers (as fine as ~0.1 Å per cycle). Precursor selection is key in ALD processes, namely finding molecules which will have enough reactivity to produce the desired films, but are stable enough to be handled and safely delivered to the reaction chamber.

| Key Element | Precursor                                            | Chemical Name                                                                                            | Gelest Product Code |
|-------------|------------------------------------------------------|----------------------------------------------------------------------------------------------------------|---------------------|
| Al          | TMA                                                  | TrimethylAluminum                                                                                        | OMAL086.2           |
| Al          | (CH <sub>3</sub> ) <sub>2</sub> Al O'Pr              | Dimethyl Aluminum Isopropoxide                                                                           | OMAL025             |
| Co          | Co(thd) <sub>3</sub>                                 | Cobalt tris(tetramethylhepta-3,5-dionate)                                                                | AKC240              |
| Co          | CoCp(CO) <sub>2</sub>                                | Cobalt Cyclopentadienyldicarbonyl                                                                        | OMCO018             |
| Cu          | Cu(acac) <sub>2</sub>                                | Copper Acetylacetonate                                                                                   | AKC260              |
| Cu          | Cu(hfac) <sub>2</sub>                                | Copper II Hexafluoropentanedionate, dihydrate                                                            | AKC253              |
| Cu          | Cu(hfac)VTMS                                         | COPPER I HEXAFLUOROPENTANEDIONATE - VINYLTRIMETHYLSILANE -<br>COPPER II HEXAFLUOROPENTANEDIONATE MIXTURE | AKC252.8            |
| Hf          | TEMAH                                                | Tetrakis(ethylmethylamido) Hafnium                                                                       | OMHF083             |
| Hf          | TDMAH                                                | Tetrakis(dimethylamido)Hafnium                                                                           | OMHF080             |
| Hf          | TDEAH                                                | Tetrakis(diethylamino)Hafnium                                                                            | OMHF075             |
| La          | La(thd) <sub>3</sub>                                 | Lanthanum tris(tetramethylhepta-3,5-dionate)                                                             | AKL435              |
| La          | La[N(SiMe <sub>3</sub> ) <sub>2</sub> ] <sub>3</sub> | Tris[bis(trimethylsilyl)amino] Lanthanum                                                                 | SIL6464.0           |
| Li          | Li(OtBu)                                             | Lithium t-butoxide                                                                                       | AKL454              |
| Li          | LiHMDS                                               | Lithiohexamethyldisilazane                                                                               | SIL6467.0           |
| Mn          | Mn(thd) <sub>3</sub>                                 | Manganese tris(tetramethylhepta-3,5-dionate)                                                             | AKM546              |
| Ni          | Ni(acac) <sub>2</sub>                                | Nickel(acetylacetonate)                                                                                  | AKN580              |
| P           | TOP                                                  | Trioctylphosphine                                                                                        | OMPH080             |
| Ru          | Ru(Cp) <sub>2</sub>                                  | Dicyclopentadienyl Ruthenium                                                                             | OMRU055             |
| Ru          | Ru(EtCp) <sub>2</sub>                                | Ruthenium Bis(ethylcyclopentadiene)                                                                      | OMRU027             |
| Sb          | Sb(DMA) <sub>3</sub>                                 | Tris(dimethylamino)Antimony                                                                              | OMAN080             |
| Se          | Bis(TMS)Se                                           | Bis(trimethylsilyl)selenide                                                                              | SIB1871.0           |
| Si          | Si(DMA) <sub>3</sub>                                 | Tris(dimethylamino)silane                                                                                | SIT8714.0           |
| Si          | BTBAS                                                | Di(t-butylamino)silane                                                                                   | SID2795.0           |
| Si          | HCDS                                                 | Hexachlorodisilane                                                                                       | SIH5905.0           |
| Si          | SiCl <sub>2</sub> H <sub>2</sub>                     | Dichlorosilane                                                                                           | SID3368.0           |
| Si          | (DMA) <sub>4</sub> Si                                | Tetrakis(dimethylamino)Silane                                                                            | SID7276.0           |
| Si          | (t-butoxy) <sub>3</sub> SiOH                         | Tri(t-butoxy)silanol                                                                                     | SIT8088.0           |
| Si          | (T-pentoxy) <sub>3</sub> SiOH                        | Tri(t-pentoxy)silanol                                                                                    | SIT8627.0           |
| Si          | BDMADMS                                              | Bis(dimethylamino)dimethylsilane                                                                         | SIB1072.0           |
| Si          | FTDS                                                 | FluoroOctylsilane                                                                                        | SIT8174.0           |

|           |                                                                      |                                                                 |           |
|-----------|----------------------------------------------------------------------|-----------------------------------------------------------------|-----------|
| <b>Si</b> | HMDS                                                                 | Hexamethyldisilazane                                            | SIH6110.0 |
| <b>Si</b> | OMCTS                                                                | Octamethylcyclotetrasiloxane                                    | SIO6700.0 |
| <b>Si</b> | SiCl <sub>4</sub>                                                    | Silicon Tetrachloride                                           | SIT7085.0 |
| <b>Si</b> | TMDO                                                                 | tetramethyldisiloxane                                           | SIT7546.0 |
| <b>Si</b> | TMDS                                                                 | tetramethyldisilazane                                           | SIT7542.0 |
| <b>Si</b> | Trisilane                                                            | trisilane                                                       | SIT8709.6 |
| <b>Si</b> | 7-Octenyltrichlorosilane                                             | 7-Octenyltrichlorosilane                                        | SIO6708.0 |
| <b>Sn</b> | Sn(DMA) <sub>4</sub>                                                 | Tetrakis(dimethylamino)Tin                                      | SNT7350   |
| <b>Sn</b> | BuSnCl <sub>3</sub>                                                  | Butyltrichlorotin                                               | SNB2000   |
| <b>Sn</b> | Sn(DEA) <sub>4</sub>                                                 | Tetrakis(diethylamino)Tin                                       | SNT7294   |
| <b>Ta</b> | PDMAT                                                                | Pentakis(dimethylamido)Tantalum                                 | OMTA075   |
| <b>Ta</b> | Ta(OEt) <sub>5</sub>                                                 | Tantalum Ethoxide                                               | AKT810    |
| <b>Ta</b> | TBTDET                                                               | (t-butylimido)tris(diethylamido)tantalum                        | OMTA082   |
| <b>Ta</b> | TaF <sub>5</sub>                                                     | Tantalum pentafluoride                                          | INTA075   |
| <b>Ta</b> | t-buN=Ta(NEt <sub>2</sub> ) <sub>3</sub>                             | Tris(Diethylamino)t-butylimino Tantalum                         | OMTA082   |
| <b>Te</b> | Bis(TMS)Te                                                           | Bis(trimethylsilyl)Tellurium                                    | SIB1873.0 |
| <b>Ti</b> | TiCl <sub>4</sub>                                                    | Titanium Tetrachloride                                          | INTI065   |
| <b>Ti</b> | TDMAT                                                                | Tetrakis(dimethylamido)titanium                                 | OMTI080   |
| <b>Ti</b> | Ti(OiPr) <sub>4</sub>                                                | Titanium Isopropoxide                                           | AKT872    |
| <b>Ti</b> | TDEAT                                                                | tetrakis(diethylamido)titanium                                  | OMTI075   |
| <b>Ti</b> | TEMAT                                                                | tetrakis(ethylmethyldamido)titanium                             | OMTI083   |
| <b>Ti</b> | Ti(OMe) <sub>4</sub>                                                 | Titanium Methoxide                                              | AKT880    |
| <b>Zn</b> | DEZ                                                                  | Diethyl Zinc                                                    | OMZN017   |
| <b>Zr</b> | TEMAZ                                                                | Tetrakis(ethylmethyldamido) Zirconium                           | OMZR083   |
| <b>Zr</b> | TDMAZ                                                                | Tetrakis(dimethylamido)Zirconium                                | OMZR080   |
| <b>Zr</b> | ZrCl <sub>4</sub>                                                    | Zirconium Tetrachloride                                         | INZR0665  |
| <b>Zr</b> | TMPZ                                                                 | ZIRCONIUM TRIS(2,2,5,5-TETRA-METHYL-2,5-DISILAPYRROLE) CHLORIDE | SIZ9920.0 |
| <b>Zr</b> | Zr(OtAm) <sub>4</sub>                                                | ZIRCONIUM 2-METHYL-2-BUTOXIDE                                   | AKZ965    |
| <b>Zr</b> | Zr(OCH <sub>2</sub> CH <sub>2</sub> SiMe <sub>3</sub> ) <sub>4</sub> | Zirconium Trimethylsilylethoxide                                | AKZ990    |

**Gelest, Inc., headquartered in Morrisville, PA,** provides technical expertise in silicon and metal-organic materials for applications in Microelectronics & Optoelectronics. The core manufacturing technology of Gelest is silanes, silicones and metal-organics with the capability to handle flammable, corrosive and air sensitive liquid, gases and solids.