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Lanthanum Titanate, $LaTiO_3$

Optical Coating Material for Visible to Mid-wave IR Coatings

Applications

Lanthanum Titanate is a high-index, low-absorption material usable for coatings in the near-UV (350 nm) to IR (>4 µm) regions. $LaTiO_3$ deposited by IAD on substrates heated to at least 250°C has very low absorption (k ~0.001) to at least 5.5 µm in the mid-wave IR. In thin film layers it is useable to ~ 8 µm. No water absorption bands are present when deposited using a densifying process such as IAD. The index remains near 2 ± 0.1 with low dispersion in the 1 to 7 um region, making $LaTiO_3$ useful as the high-index component in combination with SiO_2 or as the low-n component with Ge. Dense, hard layers can be deposited by electron-beam evaporation for antireflection and multilayer filter coatings. Lanthanum Titanate can be used in place of materials of similar index, namely, Tantalum Pentoxide or Zirconium Oxide in combination with Silicon Dioxide layers to form high index-contrast multilayer structures. Advantages over Titanium Dioxide layers are significantly reduced absorption above 900 nm and greater ease of evaporation. Hard, scratch-resistant, low stress and adherent coatings can be deposited on glass and metal substrates.

Film Properties

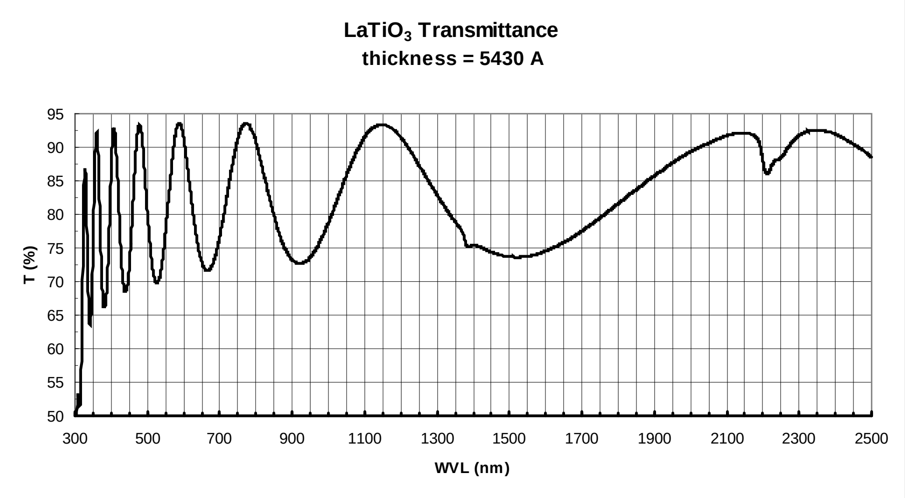
Completely oxidized $LaTiO_3$ films are absorption-free over the wavelength range below 400 nm (k<0.002 at 325 nm) to at least 4 µm. Evaporation causes a small oxygen loss and requires a partial pressure of oxygen during reactive deposition. The use of IAD during deposition results in absorption-free layers at low substrate temperatures. Stress-free layers at least 1 µm thick have shown excellent adhesion to Silicon, fused Silica, glass, and other oxide compounds. These coatings are hard, scratch resistant, and insoluble in boiling water.

$LaTiO_3$ produces an index ~2 at substrate temperatures less than that required for classical TiO_2 processes. Additionally, the influence of the La on the Ti_xO_y system results in transparency higher than that of TiO_2 below 400nm. Finally, whereas one fights high extinction coefficients with TiO_2 (even without IAD) and stressed films for high layer counts (with Ta_2O_5), $LaTiO_3$ offers more stable index, IAD feasibility and simplified reloading sensitivity than the classical TiO_2 processes.

Advantages

- High-Index, low-absorption material
- Produces dense, hard layers
- Greater ease of evaporation over TiO_2

The transmission curve presented below for a 543 nm thick layer on fused silica shows behavior that indicates excellent index homogeneity. Inhomogeneity, evidenced by inconsistent half-wave (Tmax) values, is often indicative of mixed crystal phases in coatings of refractory oxide compounds such as ZrO_2, Nb_2O_5, and HfO_2.



Transmission of a 543 nm thick deposit on fused silica with IAD and temperature 200 C. (Absorption dips are in the substrate).

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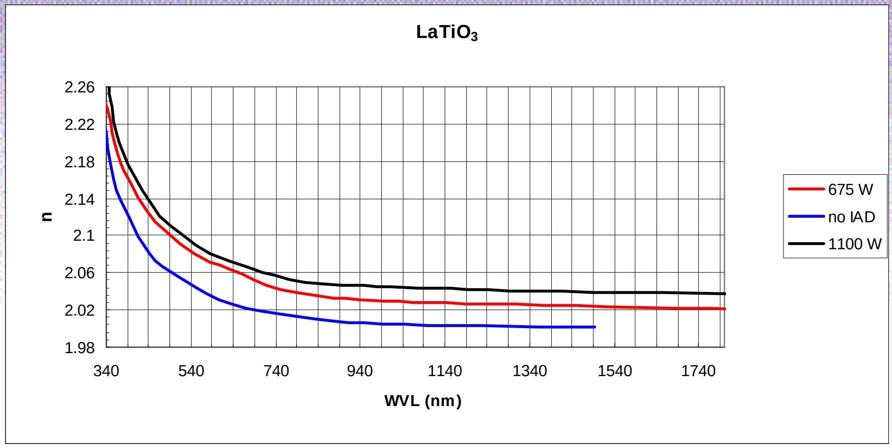
Refractive Index

Refractive indices are dependent on the degree of oxidation and the film density achieved. Deposition processes for oxide compounds typically include IAD to increase the refractive index and to discourage crystalline growth, thus producing higher packing density. With Lanthanum Titanate, the film growth is highly dense and only a small index gain is achieved with IAD. Similarly, stability to moisture is high without IAD.

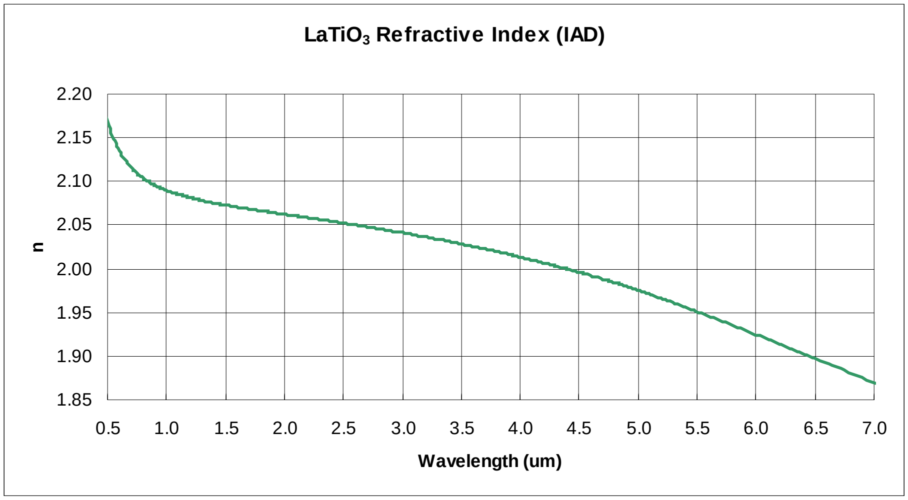
Typical index values are plotted at right for films deposited with- and without-IAD. The addition of IAD increases the index by ~0.06.



Refractive indices for e-beam deposited Lanthanum Titanate, with and without IAD (two powers) on fused silica substrates at 200 C.

Evaporation Parameters

Evaporation temperature	~2000° C
Source Container graphite liner	Tantalum or for E-beam
Rate	3-5 Å/sec.
Partial pressure of oxygen	~1 x 10^{-4} Torr
Substrate temperature	175° C to 300° C.



Refractive indices of Lantahnum Titanate in the IR region. IAD was employed.

Physical Properties of Solid Material

Molecular Weight	234.78 g/mol
Melting Point	>2000° C
Color	black
Crystal Density	6.3g/cc

Forms and Sizes Available

$LaTiO_3$ is available in pre-melted form, in shapes such as cones, rods or pieces for e-beam pockets. Please contact CERAC for more information. $LaTiO_3$ is currently not listed on the TSCA registry, therefore orders from within the US can be accepted only for R&D work at this time.

Ordering Information

For specific product information or to place an order, contact CERAC customer service at ceraccustserv@beminc.com or by phone at +1-414-289-9800. Visit www.cerac.com for a complete list of global sales and service locations.

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