MODELING AND CHARACTERIZATION OF SPECTRAL PARAMETERS IN GLAD NANOSTRUCTURED THIN FILMS

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Low refractive index optical materials are essential for multilayer interference coatings, including antireflection coatings, high-reflectivity coatings, and structures designed to enhance total internal reflection [1]. Nanostructured low-refractive-index films fabricated by glancing angle deposition (GLAD) are of particular interest for high-power laser applications, as the technique allows wide-band-gap, low-absorption materials to be structured into coatings with an effective low refractive index [2]. However, accurate characterization of their optical response remains challenging.

Fundamental ambiguities arise when characterizing SiO_2 GLAD monolayers using thin-film optics based on Fresnel equations [3]. In such case GLAD layer effective refractive index value is limited between substrate and ambient medium refractive indices. Numerical modeling of light transmittance spectra reveals multiple refractive index solutions, as different refractive index values with the same optical thickness can produce nearly identical spectral responses (Fig. 1.). These non-unique solutions are most pronounced in the central region of the examined refractive index range, where alternative solutions cannot be reliably separated using transmittance data alone.

The results show that transmittance spectra by themselves cannot determine a unique refractive index solution in structured low refractive index films. Involving numerical modeling techniques enables to estimate the accuracy and limitations of such characterization for determination of optical constants.

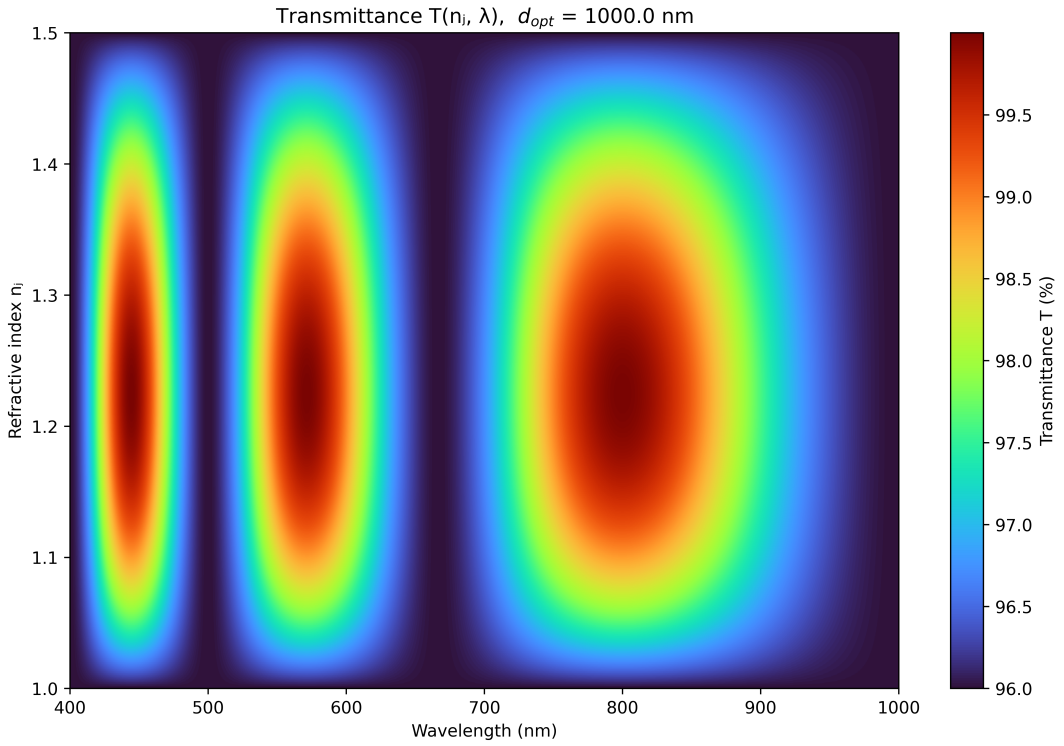

Fig. 1. Transmittance as a function of wavelength and intermediate refractive index for a single-layer thin film with air ($n = 1$) as the incident medium and a substrate refractive index of 1.5. The film has an optical thickness of 1000 nm.

Keywords: GLAD thin films, Nanostructured effective low refractive index films, Optical constants, High-power laser coatings, Fresnel thin-film optics

[1] Lukas Ramalis, Simas Melnikas, Deividas Buinovskis, Tomas Tolenis, Enhancement of total internal reflection in Nd:YAG crystals by multilayer nanostructured coatings, Optics & Laser Technology.
[2] Ramalis, Lukas & Norkute, Ugne & Grinevičiūtė, Lina & Buzelis, Rytis & Tolenis, Tomas. (2021). Sculptured thin film based all-silica mirrors for high power lasers. 43. 10.1117/12.2598667
[3] O. Stenzel, The Physics of Thin Film Optical Spectra: An Introduction, Springer Series in Surface Sciences, vol. 44, Springer-Verlag, Berlin–Heidelberg, 2005, pp. 81–95, Eq. (4.20).