

Grazing Incidence Anti-Reflection Coatings

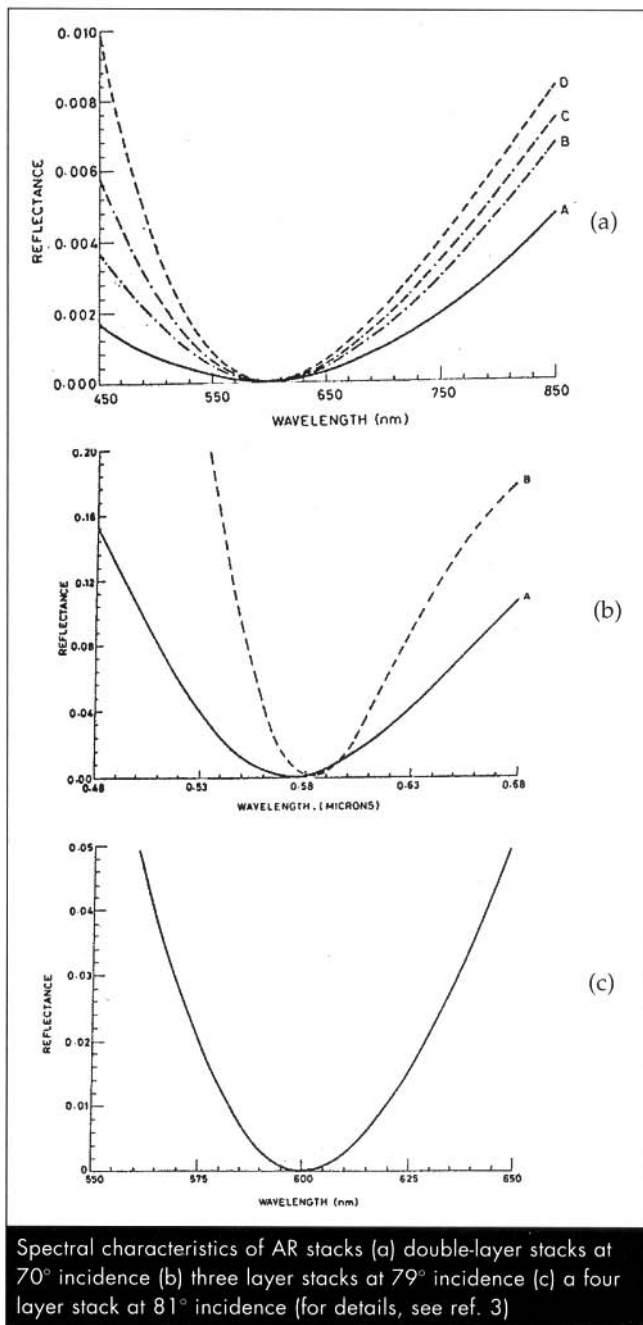
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High power dye lasers are a formidable source of tunable and coherent radiation in many scientific, industrial, and medical applications. In pulsed dye oscillators, multiple prism grating combination is generally used to get narrow linewidths and to reduce the possibility of damage to the grating surface.^{1,2} Since the magnification provided by the prism increases rapidly as the incidence angle approached 90°, these are used at grazing incidence angles. A serious disadvantage of these beam expanders is the reflection loss, which can be as high as 27% for a glass-air interface at 80° incidence for p-polarized radiation. Moreover, to use these beam expanders in widely tunable lasers, it is important that the reflection loss be minimized over a broad range of wavelengths. This makes the use of broadband anti-reflection coatings essential for these prism beam expanders.

An anti-reflection coating at normal incidence, in its most simple form, consists of a quarterwave thick layer of a material of suitable refractive index. At oblique angles of incidence, the required effective refractive index of the material, whose single quarterwave thick layer can produce zero reflectance, increases with angle of incidence for p-polarized radiation and can be as high as 3.4 for an incidence angle of 80°. This unusually high refractive index cannot be obtained with a single coating material. Even at lesser angles of incidence, for which the required refractive index is small, it may not always be possible to obtain a material whose refractive index exactly matches the required one.

We have designed broadband anti-reflection coatings by simulating the required quarterwave thick layer using two materials in an asymmetric double-layer or symmetric three layer combinations.³ The computed spectral characteristics of double-layer AR stacks based on commonly used thin film materials show, at 70° incidence, a reflectance of less than 0.5% over most part of the visible and near infrared region of the spectrum (a). A symmetric three-layer AR coating designed for 79° incidence shows a reflectance of less than 1% over 50 nm (b). Similarly, a four-layer AR coating designed for 81° incidence shows a reflectance of less than 1% over 40 nm (c). However, this wavelength range is sufficient to cover the tuning range of a single dye.

Multiple prism beam expanders have been designed using two to four prisms with incidence angle in the range of 70-80° for the entrance faces and near normal incidence for the exit faces of the prisms.^{4,5} Whereas the exit faces are given normal incidence AR coatings, the entrance faces are left uncoated. This results in a severe loss in transmission. The transmittance of a four prism beam expander can be as low as 40%.⁵ The use of AR coatings on the entrance faces can greatly improve the transmittance of the prism beam expanders and can consequently result in an improved output characteristics of the dye oscillators.



REFERENCES

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