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Durable antireflection (AR) Coatings

Unwanted reflections from lenses, windows, solar panels, etc. arise from the index-of-refraction mismatch between air and other transparent materials. The reflection can be greatly reduced by thin-film, multilayer antireflection (AR) coatings, designed for destructive interference of waves reflected from coating interfaces. For solar panels, most of the otherwise-wasted light energy is transmitted, increasing efficiency. Multilayer coatings are usually applied by vacuum-deposition methods. There are many vendors who can do this work.

I can design custom AR coatings to meet your needs, help you find appropriate contract coating labs, and work with prospective vendors to get coatings that meet your requirements at minimum cost.

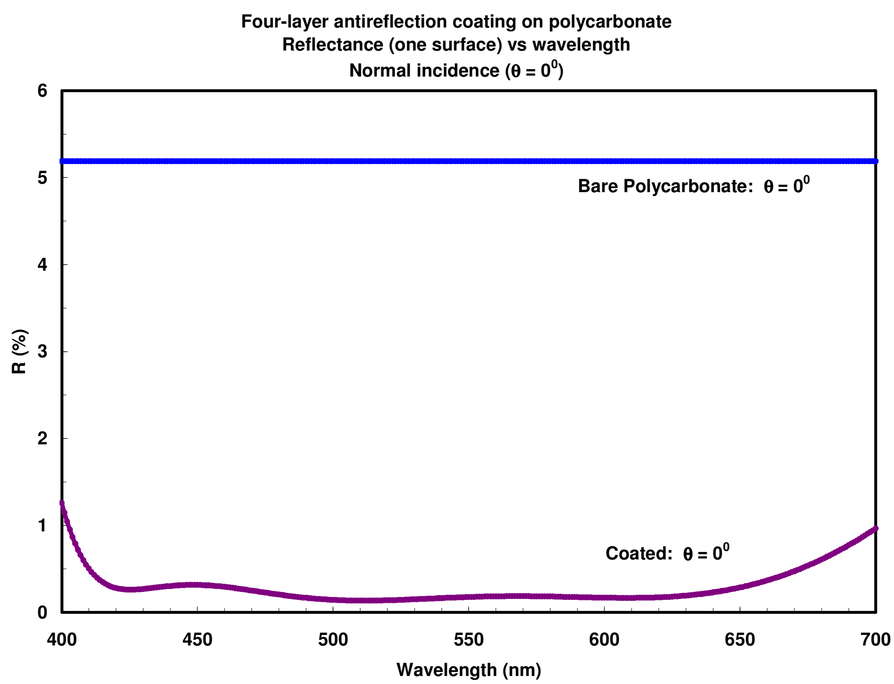
AR coatings must be optimized for application requirements (range of wavelengths, maximum permitted reflectivity, substrate material). This is generally done by starting with a "standard" design. Optimum layer materials and thicknesses are then determined by judgment, aided by coating design software.

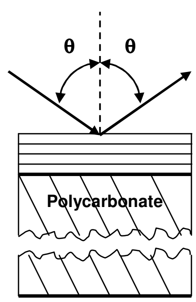
As an example, I have designed such a coating for use on polycarbonate – the material commonly used for eyeglasses. I started with a basic design – 4 layers of alternating high and low index materials [1].

To reduce cost, I chose standard materials – niobium pentoxide (Nb_2O_5) and silicon dioxide (SiO_2) – both of which are durable and can be applied to plastics. The SiO_2 outer layer resists scratching.

Layer thicknesses were optimized for minimum reflection of normally-incident (head-on) light at visible wavelengths (400-700 nm). Total coating thickness is 244 nm.

Calculated reflectance of unpolarized light from the front surface is plotted vs wavelength below. Reflectance from bare polycarbonate is shown for comparison. Note that reflection will also happen at the back side of the polycarbonate. If this surface faces air, an identical AR coating can be applied, in which case total reflection will be approximately twice that shown below for the coated sample.





This coating's performance is similar to that of the proprietary AR coatings used on plastic eyeglass lenses [2].

A problem with all interference-dependent AR coatings is excessive reflection of light rays arriving at large angle of incidence. This is due mainly to the increased distance these rays travel in each coating layer. It can be mitigated somewhat in the optimization process, but considerable reflection occurs at angles greater than ~ 45 degrees.

The same design methods are also used to develop a wide variety of optical filters – e.g. band-pass, notch, high-pass, and low-pass. I have software for the optimization of these.

[1] Peter M. Martin, *Antireflection Coatings II: Multilayer Designs,* Vacuum Technology & Coating, December 2005, pp. 6-11 (www.vtcmag.com). (Also see November 2005, pp. 6-12).

[2] K. Scherer, M. Mildebrath, and R. Bosmans, *State-of-the-Art and Challenges for Coatings on Eyeglasses*, 53rd Annual Technical Conference Proceedings, Society of Vacuum Coaters, pp. 350-356, 2010 (www.svc.org).