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Wide-angle broadband AR coating by combining interference layers with a plasma-etched gradient layer

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The realization of broadband antireflective (AR) properties for a wide range of light incidence angles is a challenging topic of optics. The performance of conventional interference stacks composed of alternating layers of high- and low- refractive-index materials is normally limited to the bandwidth of visible light and a small range of incidence angles. For the requirement of a broader spectral range combined with an incidence angle range up to 60° limitations for the residual reflectance attainable are evident. A multilayer-based AR coating consisting of silica and titania and optimized for bandwidth 400-750 nm and incidence angles from 0° to 60° will necessarily show a residual reflectance of several percent.
As an alternative to multilayer coatings, a single layer with gradual decreasing effective index from the substrate surface to the ambient medium would act much better for omnidirectional antireflection. However gradient layers with continuously decreasing index and sufficient thickness can be realized much easier for high index substrates (i.e. silicon) than for glass. On low-index substrate (glass and plastics with $n<1.6$) a suitable design solution for a wide range of incidence angles comprises at first a gradient layer with rising effective index starting from the substrate surface. After a certain maximum a gradual layer with decreasing refractive index follows. For technical reasons the rising gradient can be replaced by discrete layers of available materials. The decreasing gradient layer on top of the system should have a total thickness of 200 nm to 300 nm with a very low effective index close to that of air in the outermost region. The paper will present design calculations and first experimental results to produce suitable low-index gradient layers by plasma-etching of polymers and of vacuum deposited organic layers.

Keywords
antireflection
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nanostructure