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Publication date:
2013

Document Version
Publisher's PDF, also known as Version of record

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Citation (APA):
Christiansen, A. B. (2013). *Antireflective nanostructures replicated from black silicon*. Abstract from International Symposium on Nanoscale Pattern Formation at Surfaces 2013, Copenhagen, Denmark.

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Antireflective nanostructures replicated from black silicon

Can expensive multilayer antireflective coatings for e.g. glasses and camera objectives be replaced by cheap nanostructured surfaces? Inspired by the moth's eye, we fabricate cone-shaped nanostrucures in silicon, that significantly reduce Fresnel reflections from the surface – "black silicon" (Figure 1, top). The structures are easily fabricated on large areas using a reactive ion etching, and replicated into Ormocomp – a transparent glass/polymer hybrid material.

The random nature of the black silicon nanostrucutres will inherently scatter the light, rendering the Ormocomp surface milky-white. However, by tuning the etching process to make the nanostructures small enough, we can avoid scattering in a large part of the visible spectrum, and the structured surface becomes transparent (Figure 1, bottom right).

Using Fourier analysis of SEM images of the surfaces we can determine the dominating spatial period of the surfaces. Combined with optical measurements, we conclude that structures with a dominating spatial period of 160 nm, a height of 200 nm, and aspect ratio of 1.3 show insignificant scattering of light with wavelength above 500 nm and lower the reflectance by a factor of two.

Link: http://dx.doi.org/10.1063/1.4754691

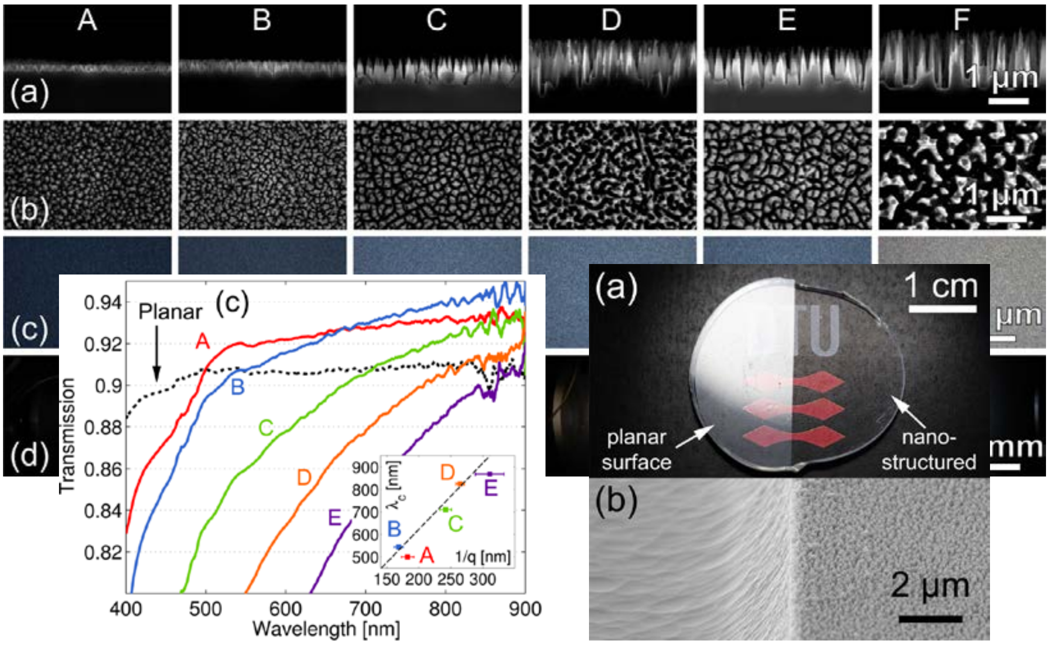

Figure 1. Top: Different types of black silicon. Bottom left: Direct transmission measurements of Ormocomp samples with antireflective structures on one face. Inset: Wavelength at intersection between transmission spectra of planar and structured surfaces, λ_c, as a function of the dominating structural periods, q^{-1}. Bottom right: Photograph of Ormocomp sample with antireflective nanostructures on top and bottom face, placed on a sheet of paper with a printed logo. Nanostructures are on the right side of the transparent sample. (b) SEM image of the sample, showing the difference between the planar (left) and the nanostructured surface (right).