Tailored nanoporous SiO_2 thin films for antireflection coatings

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Abstract

Nanoporous materials are essential in numerous applications ranging from membrane technology for e.g. separation und purification, to semiconducting and photonic industry, as low-k and low-n materials. The established methods for the synthesis of nanoporous layers encounter their limits especially if conformal coatings on high aspect ratio surfaces are required. The precise control of the porosity is also challenging. We developed a new procedure to deposit nanoporous silica (SiO_2) thin films by mixing ALD Al_2O_3 and SiO_2 in an Å-scale and subsequently removing the Al_2O_3. The composition of the films can be varied by simply adjusting the number of ALD cycles for Al_2O_3 and for SiO_2 during the process. The alumina is selectively removed in H_3PO_4 solution and the formation of nanoporous SiO_2 films is observed. The porosity and subsequently, the refractive index of the nanoporous SiO_2 films can be precisely tailored by the initial composition of the films. The porosity increases with increasing Al_2O_3 content of the ALD coating.

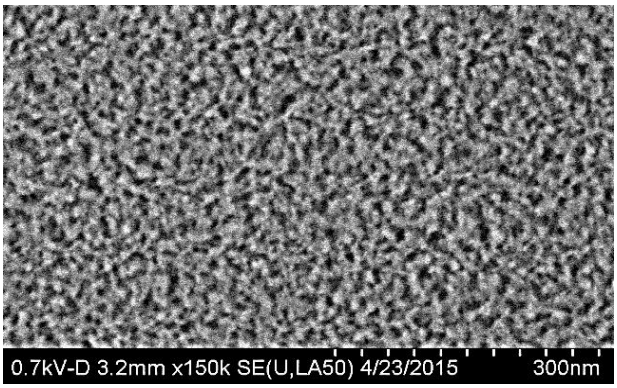

Figure 1. Scanning electron micrograph of a highly nanoporous SiO_2 thin film with a porosity of ca. 70%

Figure 1 shows a scanning electron microscopy image of nanoporous SiO_2 thin film. The porosity of this film is ca. 70% with a refractive index of approximately 1.13 at 633 nm wavelength. These coatings are highly interesting for antireflection applications. Single layer antireflection coatings have been demonstrated by simultaneously coating front and backside of quartz substrates. The film thickness of the coating determines the wavelength of the minimum reflectance.

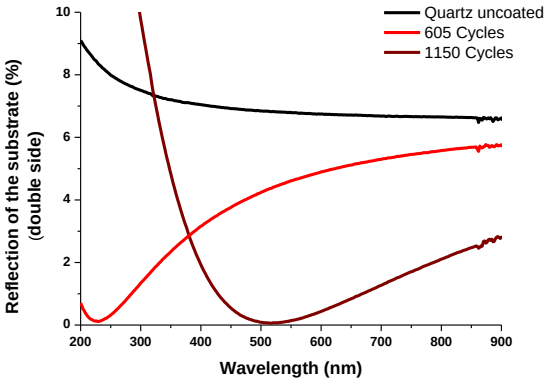

Figure 2. Reflectance spectra of double side coated quartz substrates. The total reflectance of the uncoated substrate is approximately 7%.

References

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