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Abstract

Bioinspired Microstructures Polymer Surfaces with Antireflective Properties †

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Abstract: Antireflective (AR) coatings have been around for more than a century, with the simplest form dating back to Lord Rayleigh's 1886 tarnished glass. Different approaches to obtaining AR coatings exploit index-matching, interference, or absorbing phenomena. In 2002, a novel super black surface was developed by Brown et al. at the National Physical Laboratory in the UK and soon gained significant interest among both academia and industry. Since then, scientists have been competing in a race to produce the blackest material. Although extremely valuable, existing solutions usually require complicated fabrication procedures and post-application treatments. Structural colors are ubiquitous in nature, so an interesting approach to developing AR coatings is biomimicry. Moth-eye structures are well-known for their AR properties, and they have been successfully replicated using micro- and nanofabrication methods and employed as AR coatings. Interestingly, recent studies from Harvard University highlight two types of microstructures that lead to super black coloring in nature, i.e., barbule microstructures on birds of paradise and cuticular bumps on peacock spiders. These publications provide detailed information on the shape of such natural super black microstructures and mechanisms behind the observed super black effect. Although the replication of such structures should prove extremely valuable, it has not yet been demonstrated. In this paper, we present the fabrication and characterization of AR microarrays inspired by the peacock spiders' super black structures encountered in nature. Fabrication is done by super-resolution three-dimensional (3D) printing using two-photon polymerization of an acrylic resin. The optical properties of microstructure arrays with different shape design parameters are then characterized using a homemade reflectance/transmittance setup, which allows wavelength-dependent investigations in the ultraviolet, visible, and near-infrared ranges. The influence of the shape design parameters on the optical properties of the microarrays is then discussed with experimental measurements as well as simulations.

Keywords: antireflective coating; super black structures; microstructures; biomimicry; 3D printing

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