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Glass surface modification by lithography-free reactive ion etching in an Ar/CF4-plasma for controlled diffuse optical scattering

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Micro- and nanostructuring of glass surfaces is normally realized by pattern transfer via a lithographical process including wet chemical or reactive ion etching. In this contribution we introduce a technology for structuring of glass surfaces without lithography. We make use of a self-masking effect that appears under certain process parameters during reactive ion etching in an Ar/CF_4 plasma. This way a multitude of different morphologies can be realized. In a first step an about 10nm thin unstructured metallic layer is deposited onto the cleaned glass substrates. The coating serves as a seed layer for the generation of less volatile metal fluoride compound spots that locally and temporarily prohibit further etching during the plasma treatment. Under certain plasma and etch conditions the metallic seed layer can operate as an initiator for growth of polymer spots also acting as statistically distributed etch masks. Several metals are investigated as potential seed layer materials, but only particular ones are found to be suitable for this technology. Choice of the metal coating and regulation of the etch parameters like etch time, total pressure, gas fluxes of Ar and CF_4, ion energy, and plasma density affect the resulting morphology. Modified glass surfaces are investigated using profilometry, scanning electron microscopy, and atomic force microscopy. Each morphology is characterized by its root-mean-square surface roughness and height profile correlation length. The resulting individual surface features like cones, hemispheres, pits, and trenches possess typical dimensions of 0.1 to 0.8µm. Various optical setups are used for measuring the specular and diffuse scattered light power portions in transmission as well as in reflection. The diverse morphologies show individual scattering characteristics so that nearly any proportion of diffuse to totally transmitted light power is realized. Thus user-defined light diffusers could possibly find applications in optics and optoelectronics.

Keywords
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