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Functional photocatalytically active and scratch resistant antireflective coating based on TiO_2 and SiO_2

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ABSTRACT

Antireflection (AR) multilayer coating, based on combination of five TiO_2 and SiO_2 thin films, was deposited by microwave assisted reactive magnetron sputtering process on microscope glass substrates. In this work X-ray diffraction, X-ray photoelectron spectroscopy, atomic force microscopy and wettability measurements were used to characterize the structural and surface properties of the deposited coating. These studies revealed that prepared coating was amorphous with low surface roughness. Photocatalytic properties were determined based on phenol decomposition reaction. Measurements of optical properties showed that transmittance in the visible wavelength range was increased after the deposition of AR coating as-compared to bare glass substrate. The mechanical properties were determined on the basis of nano-indentation and scratch resistance tests. Performed research has shown that deposition of an additional thin 10 nm thick TiO_2 thin film top layer, the prepared AR coating was photocatalytically active, hydrophobic, scratch resistant and had increased hardness as-compared to bare glass substrate. These results indicate that prepared AR multilayer could be used also as a self-cleaning and protective coating.

1. Introduction

An ordinary glass pane in the visible part of electromagnetic spectrum reflects ca. 9% of the incidence light – 4.5% from the front and 4.5% from back side [1]. In some applications this is not acceptable and therefore there is an increased need for creating a coating, which would decrease the level of reflection. Antireflective effect is achieved by the destructive interference of light when it is passing through a multilayer consisted of thin films with different refractive indices [1]. During past decades antireflective (AR) coatings have found wide field of applications, especially in ophthalmics, optics, flexible displays and solar cells. Nowadays, AR coatings need to exhibit new functionalities and improved quality as demands of customers are increasing [2]. Use in applications such as ophthalmic lenses, camera filters or watches AR coatings have to satisfy a set of additional requirements such as, e.g. reduction of the reflection combined with high mechanical stability. For example, such coatings should be harder than the substrate on which they are deposited, scratch resistant or possess UV-blocking properties. Most of the above mentioned applications require protection against external hazards such as impact and abrasive processes from sand or dust particles [2]. Additionally, the production of AR multilayers should be cost-effective with environmentally friendly materials used for their manufacture.

There are many deposition methods which can be used for the manufacturing of AR coatings. However dry, vacuum-based technologies have been lately intensively developed for the application in precision optics or ophthalmology [2–4]. Vacuum evaporation or sputtering are widely used in the industry and are preferred methods for the deposition of AR coatings, providing very good uniformity of the layers over very large area.

In the case of various applications AR coatings may be composed of a single layer (e.g. solar cells) or multilayer consisted of different thin films [5–8]. For the purpose of e.g. glasses or windows AR coatings are usually composed of several transparent thin films with high and low refractive index. AR coatings are usually composed of several transparent thin films with high and low refractive index. There is also a necessity for careful selection of the thin films

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