Abstract

Synergistic Effects in Nanoparticle-Based Protective Coatings for Paper and Textiles †

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† Presented at the 15th International Symposium “Priorities of Chemistry for a Sustainable Development”
PRIOCHEM, Bucharest, Romania, 30th October–1st November 2019.
Published: 15 October 2019

Keywords: multifunctional coatings; superhydrophobic; ZnO nanoparticles; Ag nanoparticles;
chitosan

Superhydrophobic materials have attracted considerable attention during the last decades, 
since they allow the facile transfer of special wettabilities properties on various surfaces. Protective 
coatings that ensure water repellency on asolid surface became the most common way for the 
treatment of stone or concrete buildings, metal devices, glass, textiles, etc. [1]. Most of these 
materials are nanohybrids consisting ofa filmogenic matrix with various nanoparticles as fillers, 
with the main role being to obtain a suitable roughness. In this work, a superhydrophobic coating 
based on a combination of ZnO and Ag nanoparticles embedded in a silica matrix was obtained and 
synergistic effects in antibacterial and other properties were investigated. Coating materials were 
prepared with various contents of ZnO and Ag nanoparticles embedded in an organo-modified 
(Ormosil) silica matrix. Ag nanoparticles were synthesized using a “green chemistry” method based 
on the reduction of silver ions in Thymus vulgaris extract. Zinc oxide nanoparticles were synthesized 
by using hydrothermal synthesis in high-temperature/high-pressure conditions, in the presence of 
surfactants as structuring agents. Commercially available normal-type paper and cotton textile were 
used as the model solid substrate to be functionalized. Ag and ZnO nanoparticles were 
characterized from the point of view of size, surface potential, crystallinity, and shape using 
dynamic light scattering, XRD, scanning electron microscopy (SEM), and transmission electron 
microscopy (TEM). The coating materials were prepared by adding various concentrations of Ag 
and of ZnO nanoparticles in a filmogenic silica matrix. The silica nanohybrid was obtained through 
the sol–gel method, and the deposition of coating material was performed by brushing or spraying 
on to a solid surface previously functionalized with chitosan. The contact angle of water on modified 
surfaces of both paper and textile materials was in the range 150–1600, with sliding angle of less than 
7°. A synergistic effect between ZnO and Ag nanoparticles was observed in terms of antibacterial 
activity, but no synergism with the chitosan was proved. Superhydrophobic multifunctional 
materials were obtained with reduced content of both Ag and ZnO nanoparticles. The coatings show
superior antibacterial activity due to the synergistic effect from the nanoparticulate components, together with UV-protection and self-cleaning properties.

Acknowledgments: This work was supported by grants of the Romanian National Authority for Scientific Research and Innovation, CCCDI–UEFISCDI, project number PN-III-P1-1.2-PCCDI-2017-0743 (PC5) and project number PN-III-P1-1.2-PCCDI-2017-0428 (PC2), within PNCDI III.

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