

Preparation and characterization of antibacterial coatings from silver containing chitosan and semiconductor materials

Emőke Volentíru, Ádám Detrich, Zsófia Molnár, Mátyás Dabóczi, Jánosné Kabai, Zoltán Hórvölgyi

Budapest University of Technology and Economics, Department of Physical Chemistry and Materials Science, H-1521 Budapest, Budafoki Street 6-8, Hungary

In recent years nanostructured wide gap semiconductors have received great attention. Oxide semiconductor thin films can be used in environmental applications (self-cleaning, antibacterial properties), sensors, solar cells, photocatalytic devices environmental applications (self-cleaning, antibacterial properties) etc. Among various semiconductors ZnO and TiO₂ are the most widely used because of their chemical stability, non-toxicity and relatively low cost. Chitosan is a cationic natural biopolymer. It becomes an interesting biomaterial due to its good biocompatibility, biodegradability and low cost.

Different semiconducting sol-gel films (from TiO₂ and ZnO) were deposited on glass substrates by dip-coating. In order to obtain layers with antibacterial properties Ag doped sol-gel coatings were prepared. Ag was incorporated into the thin films in three different ways: a) by adding directly to the precursor sol in the form of AgNO₃ solution; b) by immersing the ready-made mesoporous supported films into AgNO₃ solution; c) by mixing the sol of Ag nanoparticles with the precursor sol. To convert the Ag⁺ ions to Ag metal nanoparticles we annealed the films at high temperature. Mesoporous TiO₂ films were fabricated by using surfactant templates. ZnO precursor sols were obtained by using polyvinylpyrrolidone or diethanolamine as additives.

Ag nanoparticle containing chitosan composite films were prepared in two different ways: a) by mixing the previously synthesized stable silver sol with chitosan solution or b) by preparation of Ag nanoparticles directly in the chitosan solution. Chitosan coatings were prepared by dip coating on glass substrates and porous silica coating surfaces as well. Thickness and refractive index values of titania and ZnO coatings have been determined by UV-Vis spectroscopy and scanning angle reflectometry. Surface morphology of coatings was in certain cases studied by atomic force microscopy. Film properties were studied in terms of the preparation conditions: surfactant type and method of doping with silver. In the case of chitosan and combined porous sol-gel – chitosan films dye release investigations were carried out using UV-Vis spectroscopy.

The bactericidal activity of the coatings compared to a blank glass substrate, were studied against *E. coli* in visible light. The results related to the optical properties and photoactivity of the prepared semiconducting coatings demonstrated well their usefulness in potential applications.

Acknowledgements

*The authors thank Eszter Makkos for her help in the experimental work. The financial support of the Hungarian Scientific Research Fund (OTKA CK 78629), NKTH - A*STAR Hungarian - Singaporean Bilateral S&T International Co-operation (BIOSPONA) and the New Széchenyi Plan (TÁMOP-4.2.1/B-09/1/KMR-2010-0002) is gratefully acknowledged.*