10) ACS OmegaОткрытый доступ

Volume 4, Issue 16, 15 October 2019, Pages 16847-16859

Physicochemical Aspects of the Mechanisms of Rapid Antimicrobial Contact-Killing by Sputtered Silver Oxide Thin Films under Visible Light(Article)(Открытый доступ)

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Краткое описание Просмотр пристатейных ссылок (69)

The morphology and band gap of silver oxide thin films have been tuned by radio frequency reactive magnetron sputtering to deposit transparent, visible-light-activated photocatalytic biomaterials with excellent antimicrobial properties. X-ray diffraction, Raman spectroscopy, and X-ray photoelectron spectroscopy using the Ag 3d5/2 and Ag 3d3/2 binding energy peaks have been used to study the chemical composition of the films, and the deposition of two antimicrobial phases of silver oxide, namely, Ag2O and Ag4O4 was confirmed. The optical band gaps of the films were determined by optical spectroscopy and are in the range 2.3 eV (539.6 nm) to 3.2 eV (387.8 nm). Strong transmission of up to 80% was observed in the visible region around 650-750 nm. Silver ion release on the surfaces of the films was monitored using atomic absorption spectroscopy, and sustained silver ion release in both water and saline solution for 24 h was confirmed. Nanocrystallites of sizes between 2.45 and 31.30 nm were observed on the surfaces. The films were challenged with two Gram-positive bacteria (Staphylococcus aureus and Staphylococcus epidermidis) and two Gram-negative bacteria (Escherichia coli and Pseudomonas aeruginosa) during antimicrobial activity tests using killing curve analysis with 100% contact killing recorded in 25 and 5 min, respectively. The mechanism of antimicrobial efficacy is suggested to be due to silver ion release, small crystallites, and the ease of ligand replacement in the silver oxide stoichiometry, their exchange and interactions of ligands in the microbe's biological systems. Our current finding opens the door to furthering the development of visible-light-activated antimicrobial surfaces. 