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PREPARATION OF NOVEL Ag NANOPARTICLES DISPERSED ACTIVATED CARBON MICRO AND CARBON NANOFIBERS FOR ANTI-BACTERIAL APPLICATIONS

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Abstract

Novel Ag-nanoparticles-dispersed carbon microfibers (Ag-ACFs) and carbon nanofibers (Ag-CNFs) were prepared for applications to anti-bacterial activities. In this study, we first prepared a mono-dispersed aqueous solution of Ag(I) in water using silver nitrate ($AgNO_3$) and SDS, an anionic surfactant. Ag(I)-SDS molecules were transferred to the phenolic resin precursor based activated carbon microfibers (ACFs) by wet incipient method. The Ag-nanoparticles were produced in-situ on ACFs by calcinations at 150 ^oC and H_2-reduction at 250 ^oC. Carbon nanofibers (Ag-CNFs) were prepared by the catalytic chemical vapor deposition (CVD) at 300 ^oC using Ag-ACF as the substrate and acetylene (C_2H_2) as a carbon-source. The data showed that 12-42 nm-Ag nanoparticles were uniformly dispersed (loading of ~162 mg/g) over the surface of carbon fibers. The SEM images of Ag-ACFs and Ag-CNFs revealed that both materials were porous containing significantly large meso and micropores. Ag nanoparticles were observed uniformly dispersed within the pores. After reduction step, relatively larger size pores were obtained on the Ag-ACFs surface which permitted increased penetration of Ag nanoaprticles within the pores of ACFs. The SEM results further revealed a uniform distribution of Ag nanoparticles and dense growth of CNFs. The thickness of CNFs was observed between 13 nm to 17 nm.

The prepared materials (Ag-ACFs and Ag-CNFs) were tested against *Staphylococcus aureus* (Gram positive) and *Escherichia coli* (Gram negative) bacteria. E. *coli* and S. *aureus* were cultivated in sterilized LB broth and then incubated 24 h at 37 °C in an incubator. The microbicidal activity of prepared samples was investigated using a plate-counting method. The microorganism culture employed for the tests contained 10^7 to 10^8 colony forming units (CFU). The prepared Ag-ACF and Ag-CNF having uniformly dispersed Ag showed significant antibacterial activity against *S. aureus* and *E.coli* bacteria; the latter material was found to be superior with no significant activity observed after 72 hrs. The prepared materials completely inhibited the growth and multiplication of *Staphylococcus aureus* and *Escherichia coli.* Ag-nanoparticles attached to the DNA of bacteria stopped the protein synthesis and gene replication. The respiratory system of bacteria was also stopped. The bacterial growth was consequently inhibited.

Keywords

Ag-nanoparticles, activated carbon fibers, carbon nanofibers, chemical vapor deposition, antibacterial agent. .