INTERMATRIX SYNTHESIS OF METAL NANOPARTICLES WITH CORE-SHELL OR CORE-SANDWICH STRUCTURE FOR ANTIBACTERIAL APLICATIONS

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Metal nanoparticles (MNPs) have some unusual physical and chemical properties in comparison with bulk metals, what opens in certain instances new routs for their practical applications. The main drawback of MNPs is a great tendency for aggregation that results in their uncontrollable growth and the loss of their unique characteristics. A possible solution of this problem can be immobilization of MNPs in stabilizing polymers by using the Intermatrix Synthesis (IMS) technique. In this case the polymer matrix serves both to synthesise MNPs and to protect them against undesirable aggregation and coalescence.

In this presentation we report the synthesis and characterization of MNPs with core-shell and core-double-shell (or core-sandwich) structures of the following compositions: Ag@Cu (Ag-shell at Cu-core) and Ag@Co-Ni@Cu with various thicknesses of Ag and Co-Ni shells. The use of copper as the core-forming metal has been shown to allow for easily increasing the population density of core MNPs in the polymer matrix. The coating of Co-MNPs with Ag-shell permits to produce polymer-metal nanocomposite with bactericide properties, however the escape of Ag@Cu-MNPs from the immobilizing polymeric matrix can result in undesired post-contamination of the treated liquid (e.g., water). The proposed solution of this problem is to use ferromagnetic core-MNPs coated with Ag-shell. In this case the escape of MNPs can be easily prevented by using electromagnetic traps. The first coating of Cu-MNPs with Co-Ni-shell allows for converting the diamagnetic core into the ferromagnetic one followed by the final coating with silver-shell. The characterization of MNP sizes and compositions was done by using TEM and ICP-OES techniques, respectively. The structural parameters of core-shell and core-sandwich MNPs were calculated by using a simple model, recently proposed by the authors [1]. Optimization of IMS conditions for the synthesis of MNPs with desired structural and stability parameters was carried out in the sulfonated polyetherether keton (SPEEK) membranes. The final synthesis of MNPs with optimal parameters has been carried out in the FIBAN-K4 matrix (fibrous analogue of SPEEK), which is better applicable for the water treatment purposes. The results of water disinfection tests by using FIBAN-MNP nanocomposite filter are also presented and discussed.

Figures

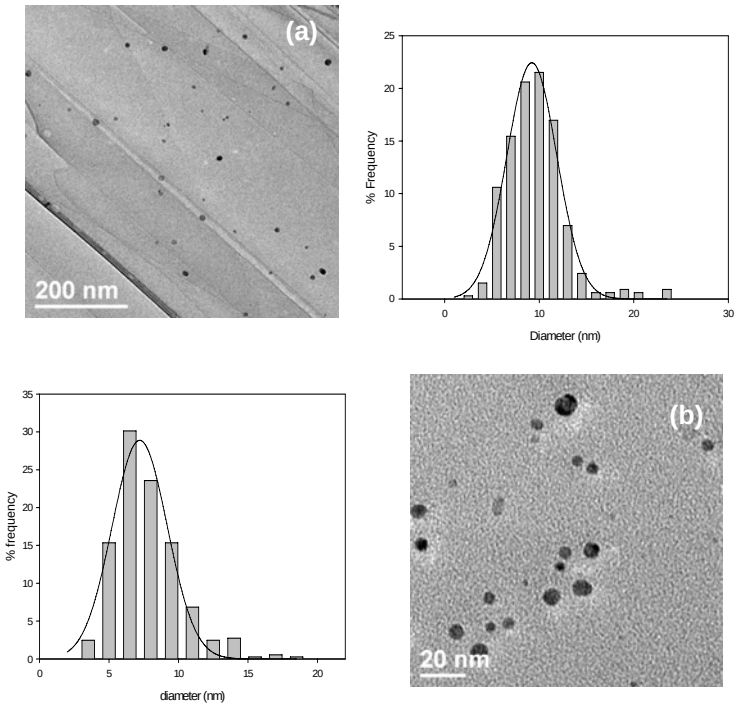

Figure 1. Typical TEM images and corresponding size-distribution histograms of Ag@CoNi@Cu MNPs obtained after loading with 16.0 mmols Ag/g membrane (a) and 1.5 mmols Ag/g membrane (b), respectively.

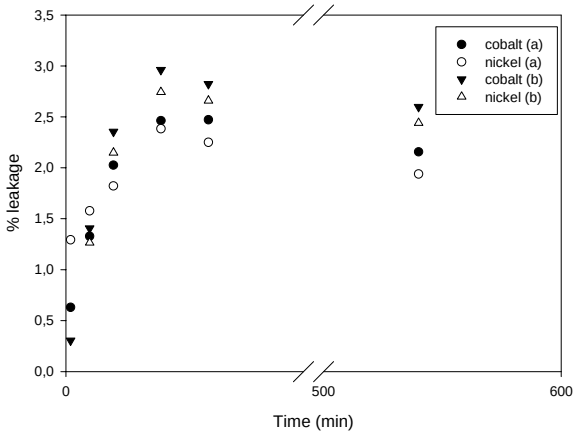

Figure 2. Percentage of Co^{2+} and Ni^{2+} leakage relative after treatment with HCl of Ag@CoNi@Cu MNPs (a) and with three times more quantity of CoNi alloy (b).

References

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2. J. Macanas, J. Parrondo, M. Muñoz, S. Alegret, F. Mijangos, D.N. Muraviev, Phys. Stat. Sol. (a) 204, 1699 (2007).