

Morphological changes of gel-type functional polymers after intermatrix synthesis of polymer stabilized silver nanoparticles

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Abstract

Ion exchange materials find numerous large-scale industrial applications in various fields, such as water treatment processes, catalysis and some others. The efficiency of the use of ion exchangers in some instances can be substantially improved by tailored modification of commercially available ion exchange materials with, for example, functional metal nanoparticles (FMNPs).[1]

The modification of ion exchangers with FMNPs can be carried out by using the Intermatrix Synthesis (IMS) technique coupled with the Donnan exclusion effect. Such a combination allows for production of polymer-metal nanocomposites with the distribution of FMNPs near the surface of the polymer what appears to be the most favorable in their practical applications. This technique has been used to modify the polymers with cation exchange functionality with FMNPs by using the procedure, which includes the following sequential stages: 1) immobilization (sorption) of metal or metal complex ions (FMNP precursors) onto the functional groups of the polymer, and 2) their chemical or electrochemical reduction.

The use of the functional polymers as supports for the metal nanoparticles (MNPs) and metal oxide nanoparticles has in this sense, one more important advantage dealing with the possibility to synthesize the catalyst nanoparticles directly at the “point of use”, i.e. inside the supporting polymer. In the case of the metal catalyst nanoparticles (MCNPs) this results in the formation of the catalytically-active polymer-metal nanocomposites.[2–5]

The antibacterial features of Ag-MNPs represent one of the hot topics of investigation in the noble metals research. The unusual properties of nanometric scale materials in comparison with those of their macro counterparts give in many instances a number of advantages in their practical applications. For example, Ag-MNPs are widely used due to their more efficient antimicrobial activity in comparison with bulk silver. Some of our previous studies dealt with the IMS of Ag-NPs on different polymer matrices and their application for bactericide water treatment. [6–8]

In the present work we present the results of IMS of Ag-MNPs in Purolite® C100E sulfonic ion exchange polymer having the gel-type structure. It has been shown that the modification of the gel – type matrix with Ag-MNPs leads to the increase of its cross-linking, what results in the increase of its surface area and the appearance of nanoporosity, as it is shown in **Fig. 1** and **Table 1**. As it is clearly seen in Fig. 1a, the morphology of the initial MNPs-free polymer is absolutely smooth but it dramatically changes after IMS of Ag-MNPs (see b,c,d,e) what can be explained by interaction of Ag-NPs with the polymer chains leading to a sort of additional cross-linking of the polymer. This results in the appearance of nanopores (see **Fig. 1e**) in the polymer gel. Ag-MNPs are located on the polymer surface and do not form any visible agglomerations (see **Fig. 1f**). All these features of the nanocomposites obtained are important for their practical applications in catalysis, in sensors and bactericide water treatment.

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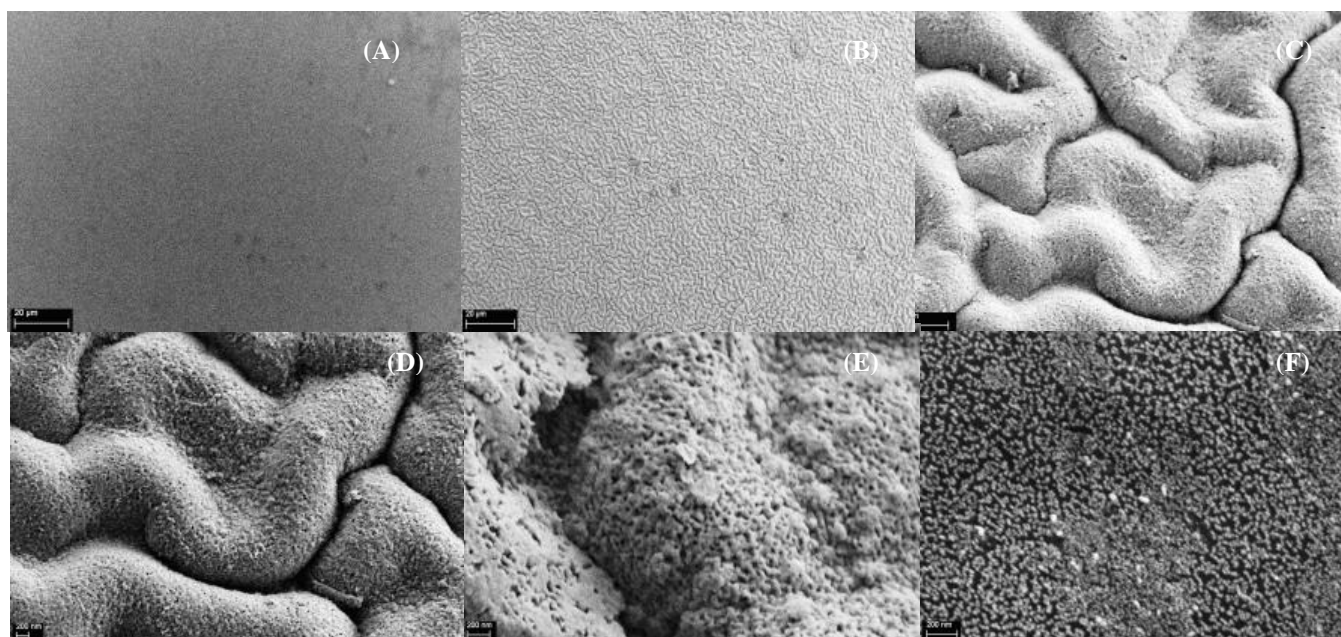


Fig.1: High resolution SEM images of C100E (a) and C100E modified with Ag-NPs. Magnification a=b<c<d<e<f.

Table 1: BET surface area analysis for C100E and C100E modified with Ag-NPs

Sample	Time of Ag ⁺ loading (min)	Surface Area (BET) m ² /g	Average Pore diameter(nm)
C100E	-	0.91	1.87
C100E with Ag-NPs	5	1.15	2.25
C100E with Ag-NPs	10	1.09	4.44