Development of new Polymer-Metal-Nanocomposites based on activated foams and textile fibers and their catalytic evaluation.

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Abstract

Nowadays research in Green Chemistry, Catalysis and Water Treatment fields has undergone an important intensification, focusing much interest and acting as a basis for the development of new techniques and materials. For instance, there is a general endeavor to develop environmentally friendly catalysts [1]. In this sense, the synthesis of Polymer-Metal-Nanocomposites (PMNCs) obtained by the incorporation of Metal Nanoparticles (MNPs) in polymeric matrices has demonstrated to be an attractive approach in the design of these catalytically active species [2].

There are two main reasons for that:

i) it has been proved that MNPs are especially effective catalysts, mainly due to their large percentage of surface atoms [3,4];
ii) by stabilizing these MNPs in a polymeric matrix, it is possible to prevent their escape to the reaction medium, thus providing an easy separation of the catalyst what, in turn, allows the possibility to reuse the catalytic species without losing efficiency [1,5].

Accordingly, special efforts are focused nowadays to the development of new nanocomposites which can enlarge the basis of suitable materials intended to be used in a wide range of applications such as: water disinfection, catalysis, energy storage, electrochemical sensors and biosensors, etc. [6,7].

In this presentation we report the ion-exchange mediated synthesis of silver nanoparticles (Ag^0-NPs) in different polymeric matrices such as polyurethane foams, and polyacrylonitrile or polyamide fibers. This synthetic methodology refers to a group of methods that can be generally classified as Inter-Matrix Synthesis (IMS) technique [8]. The main feature of IMS is the dual function of the matrix, which provides a confined medium for the synthesis (preventing Ag^0-NPs uncontrollable growth and aggregation) as well as it retains the MNPs, avoiding their release.

Anyhow, in order to apply the IMS technique, there are some requirements for the parent polymer such as: chemical compatibility with the MNPs surface, enough flexibility of the polymer chain segments, adequate swelling ratio, adequate hydrophilicity, etc. Yet, above all the mentioned features, the most important one is that the polymer must bear functional groups (e.g. $R\text{-}SO_3^-$, $R\text{-}COO^-$, $R\text{-}NR_3^+$, …) which act as nanoreactors able to bind and retain the nanoparticle ion precursors (e.g. Ag^+), while allow the ion diffusion through the matrix. Regarding this issue, and taking into account the nature of some of the chosen matrices, it was essential to activate the support material to obtain an acceptable value of Ion Exchange Capacity. Therefore, in this work different chemical pretreatments have been tested to ensure an effective Ag^0-NPs loading.

Finally, in order to evaluate the catalytic activity of the different developed PMNCs, a model catalytic reaction was carried out in batch experiments: the reduction of p-nitrophenol in presence of sodium borohydride and metallic catalyst [9,10].

References

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Figures

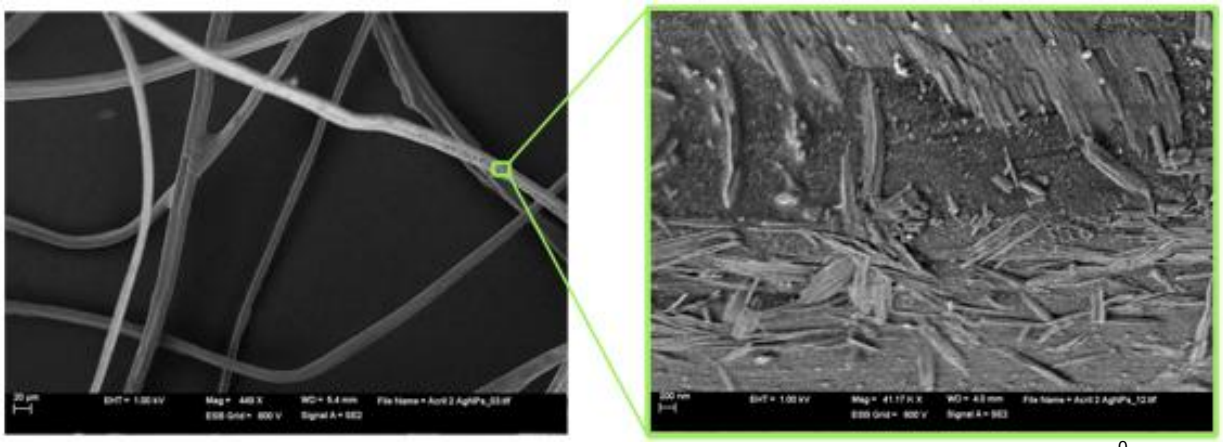

Figure 1. Typical Scanning Electron Microscopy images of polyacrylonitrile fibres containing Ag^0-NPs.

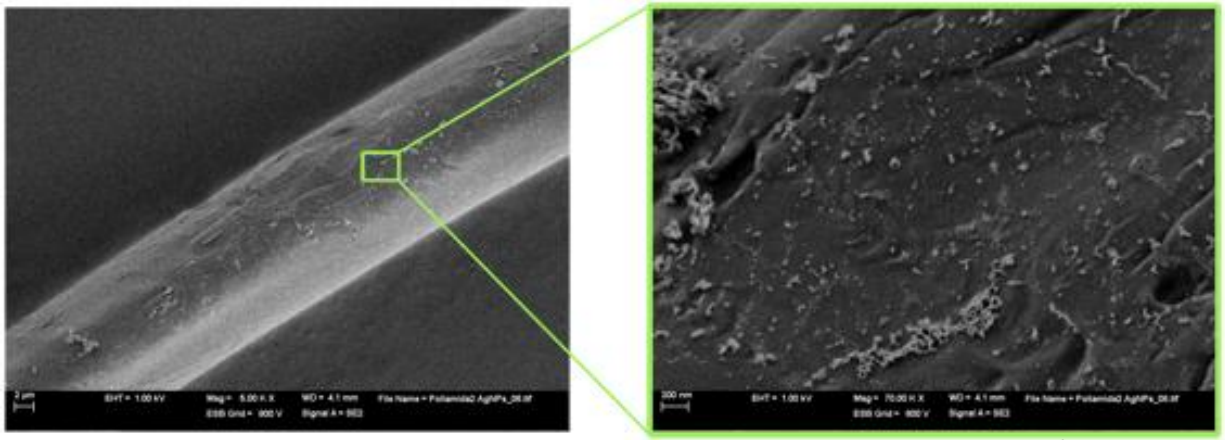

Figure 2. Typical Scanning Electron Microscopy images of polyamide fibres containing Ag^0-NPs.

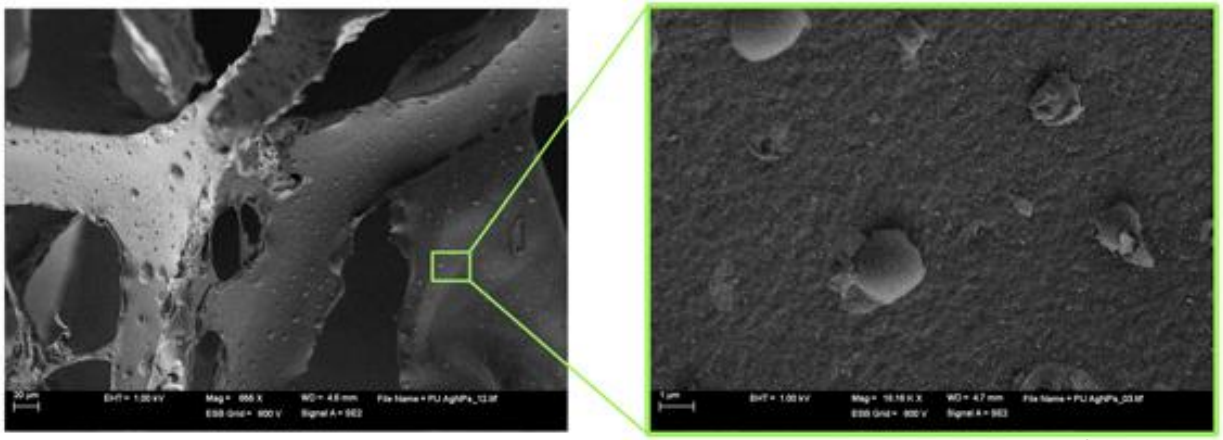

Figure 3. Typical Scanning Electron Microscopy images of polyurethane foam containing Ag^0-NPs.