ION-EXCHANGEABLE ZEOLITES AS SUPPORT IN THE SYNTHESIS OF SILVER NANOPARTICLES: ANTIBACTERIAL EFFECT IN POLYPROPYLENE NANOCOMPOSITES

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Abstract

In the present work, we consider the use of a ZeoliteW with general formula $K_{10.32}(Si_{21.7}Al_{10.3}O_{64}).H_2O$ as efficient tool to exchange K^+ by Ag^+ in aqueous solution and finally the obtention of silver nanoparticles and clusters of them by chemical reduction (decorated Zeolites with AgNP's into the cavities and surfaces). After the obtention of ZeoliteW@AgNP, the production of nanocomposites by melt compounding was carried out using a Micro-Extruder (corotatory twin screw) and polypropylene as polymeric matrix. Finally different polypropylene surfaces (PP-ZAgNP) were obtained by injection moulding and antibacterial activity against E. Coli and S. Aureus was evaluated acoording with japanese standard method JIS-Z2801 (Antimicrobialproducts-Test for antimicrobial activity and efficacy) [1].

Introduction

Antimicrobial materials play an important role in the academic and technological fields due to applications in food packaging and medicinal devices. There are many antimicrobial materials with good efficiency based in organic/inorganic hybrids. Recently, many nanocomposite materials based on thermoplastic polymers have been used as support matrix in order to obtain materials with improved antimicrobial effect using silver nanoparticles (AgNP's) [2]. On the other hand, many efforts have been focused towards the incorporation of metal nanoparticles on inorganic porous materials, in this way, the inorganic material have the abbility of act as a carrier of nanoparticles. Zeolites are a kind of aluminosilicates which possess the peculiarity of ionic exchange, specially towards cation substitution [3].

Experimental

Synthesis of Zeolite@AgNP

Procedure of the synthesis of Zeolite decorated with silver nanoparticles (Zeolite@AgNP) is showed in Figure 1, basically an aqueous solution of Zeolite W was inmersed in silver ions under different conditions of stirring and time, finally silver ions were reduced by $NaBH_4$ aqueous solution.

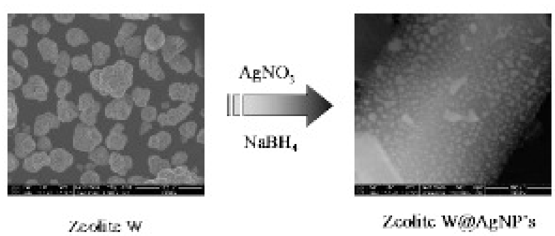

Figure 1. Synthesis of Zeolite@AgNP by chemical reduction of silver ions.

Melt compounding: Extrusion and Injection Moulding

In order to obtain nanocomposites based polypropylene (PP), melt compounding by extrusion was carried out using a Micro-Extruder (corotatory twin screw) with five temperature zones (the Figure 2 shows the diagram). The nanocomposites obtained were injected for the obtention of samples, which were cut at 1x1 cm^2 for the bactericidal evaluation.

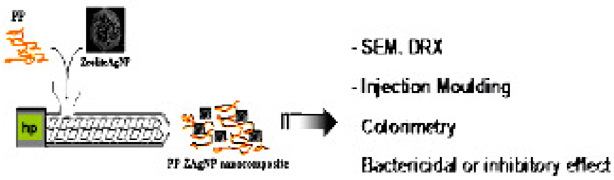

Figure 2. Obtention of Nanocomposites by extrusion.

Bactericidal Evaluation

Minimum Inhibitory Concentration (MIC) was determined with an aqueous solution of ZeoliteW@AgNP with 0.005M concentration of silver. Bacteriostatic concentration was determined by micro dilutions following the standard M7-A7 Vol 23 No. 2 CLSI (2006) (Methods for Dilution Antimicrobial Susceptibility Test for Bacteria That Grow Aerobically), S. aureus (resistant) and E. coli (ATCC95922) was used in this evaluation. Table 1 shows the results taking into account the MIC obtained.

Results and Discussion

Figure 3 shows the morphology of the pristine ZeoliteW and it can observed that the synthesis of AgNP's was succesfully reached, and their sizes are in nanometer range. The EDAX analysis shows an homogeneous distribution of the AgNP's in the Zeolite matrix.

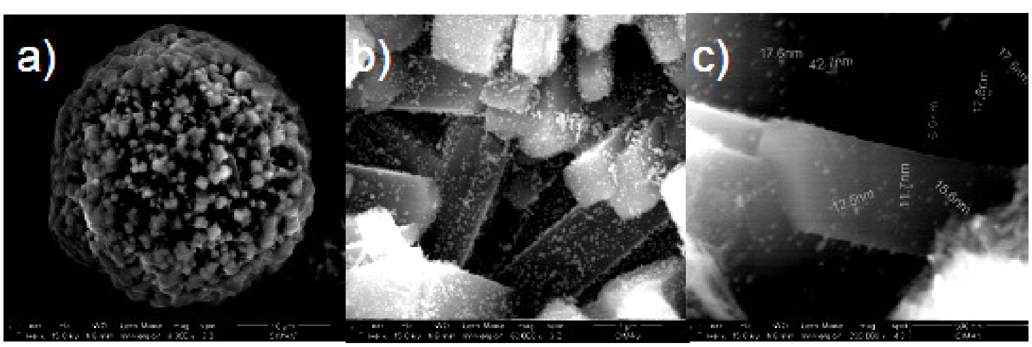

Figure 3.SEM micrographs of: a) Pristine Zeolite W, b), c) ZeoliteW@AgNP

Figure 4 shows the XRD patterns of pristine ZeoliteW and even when an overlapped of peaks, it is important to note an increased of the peak at 38.2° due to (111) plane of face centered cubic (fcc) structure of silver nanoparticles.

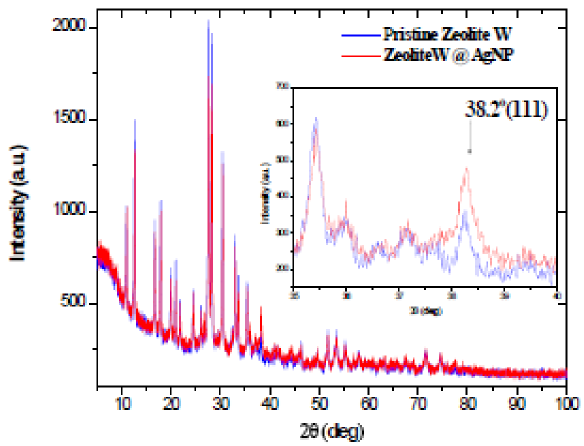

Figure 4.XRD patterns of Pristine Zeolite W and ZeoliteW@AgNP.4.

Results of the bactericidal effect will be discussed in the talk.

Conclusions

ZeoliteW results as an excellent candidate for the support of AgNP's thanks to its abbility of ion-exchange (mainly due to the presence of K^+ cations). PP-ZAgNPs nanocomposites prepared by extrusion and injection moulding were effective against E.Coli and S.Aureus growth.

Acknowledgements

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