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Effect of synthesis reaction parameters on the crystallite size of the zinc structures in antimicrobial Montmorillonite-Zinc Oxide Nanoparticles nanocomposite (MMT-NPZn)

Tanaka, A.R.K.(1); Roxo, B.O.(1); E Cardoso, R.S.(1); Brackmann, R.(1); Colpani, G.L.(2); Mello, J.M.M.(2); Silva, L.L.(2); Fiori, M.A.(1); Cima, L.B.(2); Fontana, A.M.(2);
(1) UTFPR; (2) Unochapecó;

Antimicrobial zinc oxide nanoparticles (NPZn) have been studied for application in active polymeric packaging and in polymeric devices for use in medical-hospital procedures. For this purpose, the montmorillonite was added in the synthesis reactional medium to obtain NPZn with lower sizer, to increase the antibacterial activity and to compatibilizer the nanoparticles with nonpolar polymeric matrixes. The montmorillonite is a nano clay and an interesting nucleation agent and can be used to improve the nucleation processes and improve the growth mechanisms of the NPZn in an aqueous reactional medium and to compatibilizer the NPZn with polyethylene and polypropylenes, for example. The material obtained is a nanocomposite and can be defined as antimicrobial Montmorillonite-Oxide Zinc Nanoparticles nanocomposite (MMT-NPZn). In this study, the antibacterial nanocomposites defined as MMT-NPZn were produced and characterized. An aqueous solution of Zn(NO3)2.6H20 (1.0 M) was used as a zinc specimens precursor and for neutralization of the reactional medium with different concentrations of montmorillonite (Canadian montmorillonite) dispersed in a NaOH solution (0.5 M). A complete factorial experimental design type 24 was used to define the experimental conditions. In this study, the crystallite size of the zinc structures in the nanocomposite was determined. The effect of four parameters was evaluated: temperature of the reactional medium (75.0 ºC, 80.0 ºC and 85.0 ºC), stirring time (4 hours, 8 hours and 12 hours), concentration of montmorillonite in reactional medium (1.5 g/80 mL, 3.0 g/80 mL and 4.5 g/80 mL) and the flow rate of the zinc precursor solution (1.00 mL/min, 2.00 mL/min and 3.00 mL/min). The crystallite sizes were calculated based on the data obtained with the x-ray diffraction (DRX) and using Scherrer's Equation, normally used to calculate crystallite size. In this study the crystallite size was directly associated with the particle sizes of the zinc structures of the nanoparticles. The results showed that the zinc oxide nanoparticles synthetized in reactional medium without montmorillonite has crystallite size of 85.8 nm, while the nanoparticles synthetized in reactional medium with the nano clay has crystallite size lower than 45.5 nm. The use of the montmorillonite in the syntheses process of the zinc oxide nanoparticles promote a decrease of 40-50 % in the crystallite size, that suggest a decrease of the nanoparticle sizes. The results showed too that the highest temperature (85.0 ºC), the longest flow rate (3.00 mL/min), the longest stirring time (12 hours) and the highest concentration of montmorillonite (4.5 g/80 mL), results in a bigger particle size, but lower than the nanoparticles synthetized without montmorillonite.