IVc02-001

Antimicrobial silicones by the incorporation of copper oxide nanoparticles (NPS-CuO) and zinc oxide nanoparticles (NPs-ZnO)

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Products made with silicone rubber intended for food and hospital applications are easy targets for the proliferation of bacterial and fungal biofilms, which can cause serious problems for human and animal health. In this context, few studies have devoted attention to the development of antibacterial or antifungal silicones based on the incorporation of antimicrobial nanoparticles. In this work, antimicrobial silicones were obtained and characterized by the incorporation of copper oxide nanoparticles (NPs-CuO) and zinc oxide nanoparticles (NPs-ZnO). Considering that the nanoparticles used are metallic oxides and that they can also interact with the catalyst peroxides traditionally used in the formulations of silicones and influence the vulcanization processes, in addition to the antimicrobial activities, the effects of the addition of these nanoparticles on the mechanical properties and on the thermal and rheological properties were also evaluated. Experimental plans were organized for the studies, considering the variable concentrations of NPs-CuO and of NPs-ZnO and the pressure of thermo-compression, while the temperature and the time of the vulcanization processes were defined and maintained as parameters, according to the technical literature. Pure silicone and silicones containing NPs-CuO and NPs-ZnO were subjected to antibacterial tests against Staphylococcus aureus and Escherichia coli bacteria and antifungal tests against Aspergillus niger fungus. Tests for mechanical characterization were also carried out with the aim of evaluating the effect of variables on the values of maximum stress at break, maximum deformation at the break and Young's modulus. Torque rheometry and differential scanning calorimetry tests were also carried out in order to evaluate the effect of nanoparticles on the vulcanization process of silicones.The antimicrobial results obtained for both composites are satisfactory and indicate that silicones containing NPs-CuO are more suitable for antifungal applications, while silicones containing NPs-ZnO for the antibacterial applications. The results showed that the NPs-CuO did not affect the mechanical properties and the vulcanization process, only added the antifungal activity to the silicone. However, in addition to adding antimicrobial properties, NPs-ZnO provided significant improvements in mechanical properties. The incorporation of 1% and 3% provided an increase in the maximum stress value of 74% and 34% in relation to pure silicone, respectively. With the concentration of 3% of NPs-ZnO and with thermal pressure of 11.2 MPa it was possible to increase Young's modulus of 48%. In general, the results are very promising for the improvement of future formulations for the development of antimicrobial silicones, with great technological potential for diverse applications in segments with high levels of health and food safety requirements.