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Physicochemical properties of hybrid biodegradable silica-hydrogel composites

Watanuki Filho, A.(1); Yonezawa, U.G.(2); Moura, M.R.(1); Aouada, F.A.(1);
(1) UNESP; (2) UNESP/FEIS;

Hydrogels synthesized from mixtures of synthetic and natural polymers are options to improve the biodegradability, mechanical properties and hydrophilicity, of these polymers, to expand their technological application in different areas. Thus, the polyacrylamide and carboxymethylcellulose hydrogels with added silica active particles can be classified as biodegradable polymers composed of cross-linked three-dimensional chains with controlled release behavior. The aim of this study was to analyze the absorption kinetic, spectroscopic, morphological, and structural properties of hydrogels prepared using different silica concentrations (0, 0.5, and 2.5%) in their matrices. These hybrid hydrogels were synthesized by free radical polymerization. The physicochemical properties were analyzed by swelling degree (Q), kinetic parameters from n and k constants, X-ray diffraction, scanning electron microscopy (SEM) and Fourier-transform infrared spectroscopy (FTIR). The results presented that the swelling degree were of 33.6 +- 0.3 (g.g-1), 24.8 +- 1.0 (g.g-1) and 26.2 +- 1.7 (g.g-1) for the hydrogels containing 0, 0.5 and 2.5% of silica, respectively,indicating that the presence of silica interferes directly with their water absorption. Probably, the presence of silica increased the cross-link density of the hybrid composites, decreasing the free spaces to accommodate water molecules. This result was confirmed by SEM images. The analyzes of the kinetic properties showed that there were no significant variations in the absorption velocity with the increase of the silica concentration. The values of the diffusion exponents were minor than 0.43, indicating that the release mechanism observed tends a Fickian behavior. From the FTIR spectra, it was possible to observe that hybrid hydrogels presented silica spectroscopic bands at 1384, 1120 cm-1 referent to the stretching vibrations of Si-O-Si as well as in the region at 874 and 479 cm-1 related to the stretching vibrations of the Si-OH and angular deformation of Si-O-Si. From the diffractograms it was possible to observe that all the hydrogels had an amorphous behavior. The amorphous halo of the pure hydrogel and hydrogel-silica composites were available at 2? = 21.20° and 22.58°, corresponding to d-spacing of 0.213nm and 0.201nm, respectively. Probably, this decrease is associated with the compaction of the polymeric matrix, as discussed in Q results. Furthermore, these results suggest an effective interaction between the silica and hydrogel matrix. Thus, the development of biodegradable hybrid hydrogels is relevant due to the improved properties of these composites expands their potential applications in areas such as agriculture, tissue engineering, and even in civil construction. Acknowledgments: IFSP, FAPESP, and CNPq. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – “Finance Code 001”.