Nanocomposite Fibres for Medical Applications

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Polymer nanocomposites can be produced via modification of polymers by introduction and dispersion of nanometric particles into a polymer matrix. Small amount of nanoparticles (up to 10 wt.%) can essentially improve various properties of an initial polymer. Ceramic nanoparticles form chemical bonds with polymer chains which considerably affects its mechanical and thermal properties, as well as its environmental stability.
According to the literature, this perspective group of materials may be applied in biomaterials engineering [1, 2]. Application of the nanocomposites may lead to production of bio-compatible, strong materials which can stimulate reaction of repairing tissue, as well as bio-resorbable implants with controlled resorption time.

In the work nanocomposite alginate fibres ($Ca(Alg)_2$) were fabricated. A modifying phase consisted of ceramic nanoparticles such as amorphous silica ($nSiO_2$) and natural hydroxyapatite (nHA). Both nano-fillers were characterised in respect to their size, morphology and specific surface area. Mass fraction of the nano-filler in both produced nanocomposites was 3 wt.%

Process of formation of the fibres from a solution was performed in several stages. The nano-filler particles were introduced into a spinning solution of sodium alginate (NaAlg) and dispersed with ultrasounds then the solution with a suitable viscosity was passed through spinning nozzle and produced fibres were solidified in $CaCl_2$ baths. Introduction of the nano-filler into the biopolymer matrix modified also its chemical structure.

The degree of dispersion of the nanoparticles in the polymer matrix was investigated using Fourier Transformation Infrared Spectroscopy (FTIR). The measurements were carried out in the transmission mode in the mid-infrared range (400–4000 cm^{-1}). The bands characteristic for nano-hydroxyapatite (wave number ranges of 470–600 cm^{-1} and 990–1090 cm^{-1}) were observed in $Ca(Alg)_2$/nHAp nanocomposite fibres. The same effect of nano-filler on chemical structure of the biopolymer was observed in case of the nanosilica. Characteristic bands at c.a. 1050 cm^{-1} related to Si–O bonds vibrations were present in the $Ca(Alg)_2/nSiO_2$ nanocomposite FTIR spectrum.

[1] R. Murugan, S. Ramakrishna, *Development of nanocomposite for bone grafting.* Composites Science and Technology 65 (2005) 2385-2406.
[2] Suprakas Sinha Ray, Masami Okamoto, *Layered silicate nanocomposites: a review from preparation to processing*. Progress in Polymer Science 28 (2003) 1539-1641.

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