PP and PET Nanocomposites Fibers: process, Structure and Some Applications

Ajji, A.; Bureau, M.; Denault, J.; Trudel-Boucher, D.; Dimitrievska, S.

PP AND PET NANOCOMPOSITES FIBERS: PROCESS, STRUCTURE AND SOME APPLICATIONS

A. Ajji, M. Bureau, J. Denault, D. Trudel-Boucher and S. Dimitrievska
Industrials Materials Institute, National Research Council of Canada
75 Boul. De Mortagne, Boucherville, QC, J4B 6Y4 Canada

Polymer nanocomposites (PNC) have attracted much attention during the past ten years because of their low cost and their ready availability. In comparison with the pure polymer or conventional (microscale) composites, the presence of nanoparticles in the polymer matrix can significantly increase moduli, strength, and heat resistance, and decrease gas permeability and flammability. Those properties will however depend strongly on orientation of both the matrix and reinforcement. PNCs also present an extraordinary opportunity for polymers to be used in tissue repair and reconstruction applications. Indeed, bone tissue for example is a hierarchically structured composite material formed of nanofibres containing a polymer phase, collagen type I, and a mineral phase, crystalline apatite nanoparticles, organized in a complex 3D structure. In this study, we investigated the effect of material and process parameters on the dispersion and orientation of the polymer and nanoparticles in polypropylene (PP)/Monmorillonite clay and polyethylene terephthalate (PET)/hydroxy apatite (HA) nanocomposites. As potential biomaterials targeted for load bearing bone applications of the orthopaedic/dental implant field, we also evaluated PET/HA nanocomposites biocompatibility *in vitro*

Fibers from PP and PNC as well as PET and PET/HA fibers were produced using a fiber spinning process. Various amounts of clay and HA were used. The structure of PP and PNC fibers was evaluated using field emission scanning electron microscopy (FE-SEM) and X-ray diffraction. The crystalline axes orientation factors were determined from wide-angle X-ray diffraction pole figures of (110) and (200) reflections for PP and of (001) for clay. The d-spacing of the (001) clay crystalline plane, indicative of the clay dispersion, was determined from the θ–2θ plots superimposed on the two dimensional X-ray diagrams. Similar characterization was also done on PET/HA fibers.

The results obtained for the d-spacing at small angles indicated some partial intercalation of the clay in the PNC (d spacing of 2.52 and 3.15 nm). Results on orientation of the clay (001) axis (normal to the clay platelets plane) indicated that it was oriented in the normal direction, which is expected. Its orientation in machine and transverse directions were different, suggesting that clay platelets were not randomly distributed in the transverse plane of the fibers. This was confirmed in the SEM observations showing preferential alignment of the clays. The orientation of PP crystalline axes in the fibers was slightly higher for the nano-composite that the pure resin. Tensile modulus, strength and elongation at break for both PP and PNC fibers increased with increasing draw ratio. Flexural modulus and strength of laminates made by consolidation of the PNC fibers were higher than those of consolidated pure PP fibers as well as those of bulk PP or PNC.

For PET/HA nanocomposites, X-ray results indicated that PET matrix was amorphous. Lastly L929 fibroblasts cells cultured directly on the PET/HA fibres, demonstrated a dose dependent relationship with the amount of HA present in the fibers, up to 14 days in culture. This intimate response was quantified by Alamar Blue (93% and 72% cell viability for PET 10 and PET 0 respectively at day 3) and qualified by Field Emission Gun Scanning Electron Microscope (FEG-SEM).

The ability of the PET10 fibre matrices to support L929 attachment, spreading and growth in vitro, combined with the compatible degradation extracts suggests potential use of these composites as load-baring bone biomaterials.