Biodegradable Polyesters Reinforced With Mesoporous Silica Particles

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Introduction: In recent years, the development of mechanically reinforced nanocomposites based on biodegradable polyester matrices has gained a strong incentive due to their potential use as biomaterials and to growing worldwide environmental concerns.

Objectives: This work aims to pursue this goal, and combines polycaprolactone matrices (PCL) with mesostructured silicas, by means of surface initiated acid-catalysed Ring Opening Polymerisation (ROP). Mesoporous silica materials are known as adequate carriers for hosting many types of molecules [1], and they were used here simultaneously as reinforcement filler and as carrier for ROP initiators. Metal-free ROP catalysts, based on organic derivatives of sulfonic acid, are used [2, 3] which will constitute an additional benefit from the environmental standpoint.

Methods: The reinforced polymers were prepared using high surface area SBA-15 and MCM-41 mesoporous silicas functionalised with OH groups (initiators). Methane sulfonic acid was used as catalyst for the surface-initiated ring-opening polymerisation of CL and LA.

Results and Discussion: Preliminary physical characterisation data show that for a PCL sample with moderate molecular weight (Mn~20000) and containing around 3.5% mesoporous silica (SBA-15), the mechanical properties are drastically improved, with the reinforced polymer being much tougher than neat PCL. Melt rheology measurements show that this reinforced PCL has a zero-shear viscosity nearly 5 times higher than for neat PCL, with shear-thinning visible at higher shear rates.

In spite of an expected initiation by the hydroxyl attached to the mesoporous silica framework, it was found that nearly all the PCL chains are not attached to the silica particles. MALDI-TOF results hint that this is due, in part, to the formation of cyclic PCL species by back-biting transesterification reaction.

References:

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