Tailoring glass fiber surface for the polymerization and crystallization of anionic PA6

Monomer polymerization after the impregnation of reinforcements is a relevant option for the manufacturing of thermoplastic composites by liquid processes (infusion or RTM). In the case of polyamide 6 synthesized by this process, the systems composed of monomers, catalyst and activator react within the fibrous environment. Therefore, fiber sizing is a crucial parameter because it not only influences the polymerization and crystallization processes, but also controls the fiber-matrix adhesion.

This project aims to control the interactions at the interface of glass fiber/anionic PA6 composites. To this end, different silane-based coupling agents have been used. The selected silanes were grafted onto the surface of glass microbeads of a size representative of glass fibers diameter.

Three types of interactions at the particulate-matrix interface were considered. Firstly, the surface of the glass microbeads was treated with a hydrophobic silane in order to minimize the interactions at the interface. Secondly, an amino-silane was used to create weak bonds (hydrogen bonds) between the glass beads and the matrix. Finally, the glass beads were treated with a silane allowing the formation of covalent bonds between the beads and the matrix, by initiating polymerization from the surface of the microbeads.

After treatment, the surfaces of the beads were characterized using contact angle measurements, Fourier transform infra-red spectroscopy (FTIR) and X-ray photoelectron spectroscopy (XPS). The results show that surface modification was successful. Then, glass microbeads/anionic PA6 composites were synthesized in a differential scanning calorimetry (DSC) apparatus to examine the influence of the chemical nature of the treatment, and the degree of grafting, on the polymerization time and the degree of crystallinity.

The DSC results, combined with the surface characterization results, show that the treated glass microbeads accelerate the polymerization process compared to the untreated beads case. In addition, the degree of crystallinity slightly increases for treated beads compared to the neat resin and untreated beads. The influence of the chemical nature of fiber sizing and of the grafting degree on the synthesis of the matrix was thus demonstrated.

Next, the mechanical performance of the fiber-matrix adhesion at the interface will be evaluated by analyzing the mechanical response of composite specimens (traction and/or bending). This will allow identification of the optimal level of interaction between the reinforcement and the matrix, in order to provide better mechanical properties of glass fiber/anionic PA6 composites.