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Nanofibrillar-, Microfibrillar- and Microplates Reinforced Composites – New Advanced Materials from Polymer Blends for Technical, Commodity and Biomedical Applications

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Microfibrillar reinforced composites (MFC) are prepared from polymer blends of thermodynamically *immiscible* partners having different melting temperatures, T_m . The essential steps of MFC preparation are: (i) melt blending with extrusion, (ii) drawing with good orientation, and (iii) thermal treatment above T_m of the lower-melting component and below T_m of the higher-melting one. During the drawing microfibrils are created (*fibrillation step*); in the subsequent processing – melting of the lower-melting component occurs (*isotropisation step*), with preservation of the microfibrillar structure of the higher-melting component.

The mechanical properties of MFC are close to those of commercial short glass fibre-reinforced thermoplastics with the same matrix. When the starting blend comprises two condensation polymers, a *self-compatibilization effect* is also observed due to the interchange chemical reactions resulting in the formation of a copolymer at the phase boundaries. MFC involving polyolefins, such as polypropylene (PP) or polyethylene (PE) as matrices, and poly(ethylene terephthalate) (PET) as reinforcement, show the same morphological and structural characteristics as the better studied MFC types based on condensation polymers involving PET and polyamides. Their mechanical parameters (tensile strength and Young's modulus) are up to five times higher as compared to the neat PP and PE matrices. As compared to short glass fibre (GF)-reinforced composites (30 wt% GF), having the same matrix (LDPE), the MFC have approximately the same Young's modulus and tensile strength as well as much better (up to 10 times) deformation ability. The manufacturing and processing of MFC is successfully realized on commercial scale equipment. MFC have good application opportunities in the car production since they do not contain mineral reinforcement.

The MFC concept is further applied for manufacturing of microplates reinforced composites (MPC) *via* pressing of the non-drawn extrudate in order to transform the spheres into plates and subsequent processing for manufacturing of films or thin-walled containers. By selecting MPC partners with mutually complementing barrier properties (e.g. PET/PE or PET/PP) it is possible to improve the barrier properties of the conventional packaging materials consisting of a single polymer.

Applying again the MFC approach, nanofibrils, characterised by extremely homogeneous diameters (around 100 nm), were recently obtained and isolated as a single material. The isolation of nano- and microfibrils *via* selective dissolution of the second blend component offers potentials for their biomedical applications as scaffolds for the regenerative medicine or as carriers for controlled drug delivery as well as nanofilter materials.