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Editorial corner – a personal view

Where micro- and nano-worlds meet: multiscale polymer composites

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In the last twenty years a large amount of scientific data has been published on the preparation and characterization of polymer nanocomposites. Despite the very intense research efforts, the mechanical properties reported so far for nanocomposites are quite disappointing, particularly when compared to that of structural composites reinforced with high-performance continuous fibers (DOI: 10.1126/science.1151434). Among the main causes invoked to explain the obtained results one could mention i) poor dispersion and alignment of nanofillers, ii) difficulties in achieving an elevated volume fraction of nanofillers and iii) scarce bond and load transfer ability at the nanofiller/matrix interface. Intensive research is currently ongoing to tackle and possibly solve the above mentioned problems. Recently, new strategies emerged for the preparation of structural materials in which both micro- and nano-reinforcements coexist in multiscale composites (DOI: 10.1177/0731684412456612). Nanoscale reinforcements have been included within fiber reinforced composites in several ways, such as i) grafting or electrophoretic deposition (mostly of carbon nanomaterials) onto the fiber surface (DOI: 10.1016/j.compscitech.2014.06.019), ii) localization in sizing/coatings for fiber treatment (DOI: 10.1016/j.compositesa.2012.08.027) iii) homogeneous dispersion in the whole polymer matrix (DOI: 10.1177/0731684414542668). The presence of nanoreinforcements in traditional microcomposites has been proven to play beneficial effects on several properties, including delamination resistance, fiber/matrix shear strength (DOI: 10.1016/j.compscitech.2012.12.016), electrical and thermal conductivities. The possibility to improve the electrical conductivity of typically insulating materials such as glass/epoxy laminates, is opening new possibilities for the monitoring of deformation and damage in composite structures under service. For example, it has been proven that an integrated system of carbon nanotubes and piezoelectric sensors can be used to detect both microcracks and localized damage/delamination in composite structures (DOI: 10.1016/j.carbon.2012.04.008). Therefore, nanomodified matrices can be used for a continuous monitoring of deformational levels and damage of structural composites under various loading conditions such as fatigue, impact and creep (DOI: 10.1016/j.compositesa.2012.03.019). Can we dream of polymer composites in which micro- and nano-structures synergistically operate to provide both structural and functional features, including self-repairing and adaptive responses?

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