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Scale effect on tribo-mechanical behavior of vegetal fibers in reinforced bio-composite materials

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Abstract:

The nature of friction of vegetal fiber and polymeric matrix in bio-composite materials is very important for many industrial applications. In order to design natural fiber composites for structural applications, the scientific understanding of tribo-mechanical phenomena inside the heterogeneous structure of natural fibers and also the overall heterogeneous structure of the bio-composite is required. This implies a special focus on the fundamental aspects of vegetal fiber friction at the macro-, meso-, and microscale. This research paper investigates the multiscale mechanical and friction properties of natural fibers. The mechanical properties of flax fibers, glass fibers (as a reference) and polypropylene matrix has been evaluated at microscale and mesoscale by Atomic Force Microscopy (AFM) and Nanoindenter XP (MTS Nano Instruments), respectively, using nanoindentation technique. At the macroscale, the mechanical behavior has been considered for the global composite structure. The micro-friction response of each composite component has been measured by instrumenting AFM for scratch test technique. The results show the scale dependence of mechanical behavior for flax fibers, unlike glass fibers and polypropylene matrix where their mechanical performances are independent of the analysis scale. Tribological results in terms of dynamic friction coefficient show that flax fibers induce more friction than glass fibers, while polypropylene matrix generates the highest friction. This is sign that vegetal fiber friction is scale dependent property as shown when referring to the contact mechanics theory. The arisen results are very important for many technical applications in PMCs surface engineering based on plant fibers.

Keywords:

Vegetal fibers; A. Polymer-matrix composites (PMCs); B. Friction/wear; B. Mechanical properties; D. Atomic force microscopy (AFM).

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