Impact of fiber pre-opening and number of passes on the properties of recycled carbon fibers from carded webs

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Abstract

The reuse of recycled carbon fibers (rCF) addresses environmental concerns in the composites industry by offering a sustainable alternative to virgin carbon fibers. Recycling and reusing carbon fibers reduces waste at the end of the life cycle of composite materials and decreases dependency on virgin raw materials. While recycling methods effectively recover carbon fibers from end-of-life composite products, these processes often yield shorter fibers, complicating their reintegration into high-performance applications. Challenges such as achieving fiber alignment and improving processability are further exacerbated by the brittle nature of rCF and the absence of sizing, which typically enhances fiber-matrix bonding and handling.

Carding, a technique traditionally used in the textile industry to disentangle and give continuity to short fibers, has shown promise in addressing these challenges for recycled carbon fibers. Previous studies conducted on laboratory-scale carding machines demonstrated that blending rCF with crimped thermoplastic fibers, such as polypropylene (PP), during carding reduces fiber breakage and does not degrade the mechanical properties of rCF. Statistical analysis of tensile data from carded webs also indicated an improvement in the uniformity of tensile modulus values with increasing amounts of crimped thermoplastic fibers.

In this study, the focus extends beyond blend ratios to investigate additional parameters of the carding process, such as the number of passes through the carding machine and the opening of the fibers. Tensile properties, including stress at break, modulus, and elongation at break, are evaluated to understand the influence of these parameters on the quality and mechanical performance of the fibers in the resulting carded webs. A statistical approach is employed in order to further understand the impact of those parameters, especially on the scattering in tensile data.

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