

**Cellulose Fiber-Reinforced Thermoplastic Composites:
Processing and Product Characteristics**

by

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Cellulose Fiber-Reinforced Thermoplastic Composites:
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(Abstract)

Steam exploded fibers from Yellow Poplar (*Liriodendron tulipifera*) wood were assessed in terms of (a) their impact on torque during melt processing of a thermoplastic cellulose ester (plasticized CAB); (b) their fiber incorporation and dispersion characteristics in a CAB-based composite by SEM and image analysis, respectively; and (c) their impact on the mechanical properties (under tension) of CAB-based composites having fiber contents of between 10 and 40% by weight. The fibers included water-washed steam exploded fibers (WEF), alkali-extracted fibers (AEF), acetylated fibers (AAEF), all from Yellow poplar ($\log R_o = 4.23$), and oat fillers (COF) as control. The stepwise increase in cellulose content by extraction, and especially the (surface) modification by acetylation, contributed to increased torque during melt processing, and to improved interfacial adhesion as well as fiber dispersion. As compared to pure CAB, AAEF generated the highest increase in torque (+ 421%) followed by AEF (+ 260%) and WEF (+ 190%) at 40% fiber content by weight. AAEF was also found to enhance the tensile properties of the resulting composites. SEM studies of the tensile fracture surfaces indicated significant interfacial delamination and also pull - out of fibers when WEF, AEF, and COF were used to reinforce the CAB matrix. Composites with AAEF, by contrast, revealed fracture surfaces with reduced interfacial delamination and with significant fiber fracturing during failure. Image analysis was used to determine fiber dispersion within the resulting

composites quantitatively. Significant improvement in fiber dispersion was achieved when the matrix was reinforced with acetylated fibers (AAEF). Fiber addition to the matrix resulted in loss of strain at break (- 80 to - 93%) and slight or significant increases in modulus (+ 47 to + 103%) depending on fiber type at 40% fiber content. Maximum stress declined for all fibers except AAEF at all fiber contents. AAEF-based composites revealed a decline in maximum stress when fiber content rose to 10%, and this reversed when fiber content increased beyond 10%. This increase in strength is consistent with the rule of mixtures that stipulates reinforcement of the matrix by fibers that are capable of transferring stresses across the fiber-matrix interface. All fibers suffered length decreases during melt processing.

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