LYOCELL FIBER-REINFORCED CELLULOSE ESTER COMPOSITES – MANUFACTURING CONSIDERATIONS AND PROPERTIES

by

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ABSTRACT

Biodegradable thermoplastic composites were prepared using high modulus lyocell fibers and cellulose acetate butyrate (CAB). Two reinforcement fiber types: fabric and continuous fiber tow were used. Fabric had advantages of uniform alignment and easier processing, but lacked the use as a unidirectional reinforcement and a continuous method of matrix application. Three different matrix application methods were screened for both fiber types. Matrix application by suspension of particles in water was not feasible because of particle sizes > 15 µm. The other disadvantages were high moisture absorption during matrix application and void formation during consolidation. Melt processing technique using alternating sandwich structure of fabrics and CAB films produced composites with impressive appearance, low void contents and low moisture absorption. However, SEM results revealed interfacial failure and extensive fiber pull out. Relatively larger fiber and matrix regions were present on the scale of 10⁻³ m. Solution prepregging technique using methyl ethyl ketone (MEK) as a solvent for CAB and continuous fibers as reinforcement produced composites with uniform matrix distribution, high tensile strengths and high modulus, and even wetting of fibers by CAB. A maximum tensile modulus of 21.5 GPa and a maximum strength of 251.7 MPa were achieved for a continuous fiber reinforced composites at a volume fraction of 66.5% compared to 0.8 GPa and 76 MPa for the matrix, respectively. Void contents and water absorption were relatively high compared to comparable carbon fiber composites.
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GLOSSARY

σ  Tensile Stress (MPa)
ρ_m  Density of matrix (gm/cm³)
ρ_f  Density of fiber (gm/cm³).
E  Modulus of Elasticity (GPa)
M_d  Measured composite density (gm/cm³)
T_c  Crystallization Temperature (°C)
T_d  Theoretical density of composite (voidless basis) (gm/cm³)
T_g  Glass Transition Temperature (°C)
T_m  Melting Temperature (°C)
X_c  Degree of Crystallinity (%)
V  Void Content of Composite, volume %,
V_f  Volume Fraction of Fiber in Composite (%) 
V_m  Volume Fraction of Matrix in Composite (%)
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