Thermomechanical Performance of Recycled Plastic/Rice Husk Composites Incorporating Activated Carbon-Encapsulated Polyethylene Glycol

Ruey Shan Chen
Senior Lecturer, Faculty of Science and Technology, Department of Applied Physics, Universiti Kebangsaan Malaysia, Malaysia

Abstract:
The development of sustainable building materials with integrated thermal regulation capabilities is increasingly important for improving energy efficiency in tropical environments. This study investigates the thermomechanical performance of recycled high-density polyethylene/polyethylene terephthalate (rHDPE/rPET) and rice husk (RH) composites incorporating activated carbon (AC)-encapsulated polyethylene glycol (PEG) as a form-stable phase change material (PCM). Biomass-derived AC prepared from oil palm fibers exhibited a high specific surface area of 492.46 m^2/g and an average pore diameter of 2.08 nm, facilitating effective PEG encapsulation through capillary action. Leakage tests identified 40 wt% PEG loading as the optimum level for shape stabilization. Differential scanning calorimetry (DSC) confirmed the retention of phase-change functionality following encapsulation. Upon incorporation into the recycled plastic/rice husk matrix, the composites exhibited lower latent heat capacities than the standalone PCM, accompanied by dilution within the polymer-fiber matrix and restricted PEG crystallization. Concurrently, tensile testing revealed a progressive decrease in tensile strength and Young's modulus with increasing PCM content. The findings provide valuable insights into balancing thermal functionality and structural performance in sustainable recycled plastic/rice husk biocomposites for non-load-bearing building applications.