# High Strength, High Toughness Polyhydroxybutyrate-Co-Valerate Based Biocomposites

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**Abstract :** Biocomposites is a field that has gained much scientific attention due to the current substantial consumption of non-renewable resources and the environmentally harmful disposal methods required for traditional polymer composites. Research on natural fiber reinforced polyhydroxyalkanoates (PHAs) has gained considerable momentum over the past decade. There is little work on PHAs reinforced with unidirectional (UD) natural fibers and little work on using epoxidized natural rubber (ENR) as a toughening agent for PHA-based biocomposites. In this work, we prepared polyhydroxybutyrate-co-valerate (PHBV) biocomposites reinforced with UD 30 wt.% flax fibers and evaluated the use of ENR with 50% epoxidation (ENR50) as a toughening agent for PHBV biocomposites. Quasi-unidirectional flax/PHBV composites were prepared by hand layup, powder impregnation followed by compression molding.  Toughening agents – polybutylene adiphate-co-terephthalate (PBAT) and ENR50 – were cryogenically ground into powder and mechanically mixed with main matrix PHBV to maintain the powder impregnation process. The tensile, flexural and impact properties of the biocomposites were measured and morphology of the composites examined using optical microscopy (OM) and scanning electron microscopy (SEM). The UD biocomposites showed exceptionally high mechanical properties as compared to the results obtained previously where only short fibers have been used. The improved tensile and flexural properties were attributed to the continuous nature of the fiber reinforcement and the increased proportion of fibers in the loading direction. The improved impact properties were attributed to a larger surface area for fiber-matrix debonding and for subsequent sliding and fiber pull-out mechanisms to act on, allowing more energy to be absorbed. Coating cryogenically ground ENR50 particles with PHBV powder successfully inhibits the self-healing nature of ENR-50, preventing particles from coalescing and overcoming problems in mechanical mixing, compounding and molding. Cryogenic grinding, followed by powder impregnation and subsequent compression molding is an effective route to the production of high-mechanical-property biocomposites based on renewable resources for high-obsolescence applications such as plastic casings for consumer electronics.

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