PhD. Thesis Defend Examination

Presented by
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Effects of Thermosets and Thermoplastics in Agro-waste Based Composites

Highlight Summary

The rapid expansion of global population and industrialization has heightened demand for sustainable materials while simultaneously increasing the generation of agricultural residues, Among these, sugarcane bagasse (SCB) offers immense potential as a renewable reinforcement for biocomposites. Despite its abundance and high cellulose content, the direct incorporation of SCB into polymer matrices is limited by its inherent hydrophilicity, poor interfacial bonding and low thermal stability. To overcome these limitations, this study systematically investigates the chemical modification of SCB fibers and evaluates their integration into both thermosetting and thermoplastic matrices, Comprehensive fiber characterization confirmed that chemical treatments enhanced the structural and functional properties of SCB fiber by increasing crystallinity, reducing hemicellulose and lignin content, and improving thermal resistance. Among the treatments, alkali modification exhibited the most significant improvements, yielding the highest density (1.311 g/mL) compared to silane (1.281 g/mL) oxalic acid (1.272 g/mL) and untreated fibers (1.266 g/mL). x-ray diffraction confirmed cellulose type I as the dominant crystalline phase, with crystallinity indices rising notably after mercerization, SEM micrographs revealed distinct morphologies for all fibers prior and after chemical treatment highlighting the changes to the fiber surface during modifications. Thermogravimetric analysis indicated superior thermal stability in silane-treated fibers, closely followed by alkali treatment. When incorporated into thermoset matrices, the treated SCB fibers significantly enhanced physical and mechanical performance. Alkali treatment provided the greatest improvements, yielding higher tensile strength, modulus and hardness, UPR composites displayed increased impact strength with fiber addition, while bio-epoxy composites initially showed reduced toughness that was partially mitigated by fiber treatments, SEM fracture analysis supported these findings, revealing enhanced fiber-matrix interlocking in treated samples. Water absorption and contact angle measurements indicated that chemical modifications enhanced hydrophobicity and reduced moisture uptake, further supporting composite durability, Similarly. In thermoplastic systems, chemical treatments also improved interfacial bonding, as evidenced by reduced voids and enhanced mechanical performance. Silane alkali treated fiber composites exhibited superior impact strength and hardness, while SEM analysis highlighted reduced fiber pull-out and more uniform fiber dispersion. Thermal studies revealed distinct degradation profiles and improved stability in treated samples with activation energy analyses confirming the stabilization effect of chemical modification. Moisture absorption and wettability tests reinforced the role of silane and alkali treatments in enhancing hydrophobicity and barrier properties. In addition to mechanical and thermal behavior, the tribological performance of SCB-reinforced composites was extensively investigated for both thermosets and thermoplastics using a Taguchi experimental design, supported by ANOVA and regression modeling. In PLA, wear resistance was primarily governed by fiber content, while friction depended on load; HDPE showed stronger load dependence for wear, with both load and fiber content affecting friction. Morphology revealed a shift from severe abrasive wear at low fiber loadings and high loads to smoother wear at higher fiber contents, For thermosets, applied load dominated wear and friction, with bioepoxy outperforming UPR due to stronger fiber-matrix adhesion, showing uniform wear tracks and minimal fiber detachment, whereas UPR exhibited matrix cracking and fiber pull-out. These results demonstrate that SCB's tribological effectiveness is strongly matrix-dependent, emphasizing the importance of fiber loading and matrix selection for optimized performance.

27 November 2025	13.00 - 16.00 Hrs.	5th Floor, KMUTNB Techno Park Building

Registration is open from today until November 14, 2025.

QR Code for Registration