INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title:
Synthesis and characterization of poly(lactic acid) based antimicrobial bio-nanocomposites for potential food packaging applications

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Biopolymers or biodegradable polymers have gained enormous attention worldwide as an alternative to synthetic plastic mainly due to their biodegradability, non-toxic, and renewable resources. Among different biopolymers, poly(lactic acid) (PLA) is the most widely used material in food packaging applications. However, like other biopolymers, PLA has limitations, such as poor thermal, mechanical, and barrier properties compared to synthetic non-degradable plastics. But, storage and transporting any product, especially food, requires a strong, tough material that can withstand any harsh conditions encountered during transportation and storage. Moreover, packaging should preserve food quality, prolonging the product's shelf life. Given the above, the present doctoral work aims to synthesise poly(lactic acid) based bio-nanocomposites by incorporating different nanoparticles/antimicrobial additives with enhanced physiochemical properties for potential food packaging applications. The ultrasound-assisted solvent casting method is used to synthesize PLA-based antimicrobial bio-nanocomposites with four different nanoparticles/ additives viz. ZnO nanoflowers, functionalized ZnO, ZnO@HNT and CEO/alkali-treated HNT. The ZnO nanoflowers were synthesized via a facile sonochemical method with $Zn(NO_3)_2{\cdot}6H_2O$ as a precursor in different molar concentrations (0.025, 0.05, 0.075 and 0.1 M). The physiochemical characterization of the nanocomposites revealed excellent thermal, optical and mechanical properties at a very low loading of ZnO (0.5 wt%). The second chapter reported the synthesis and surface modification of ZnO nanoparticles with 3-aminopropyltrimethoxysilane coupling agent (APTMS). Thereafter, the nanocomposites of PLA with surface-modified ZnO were synthesized by ultrasound-assisted solvent casting method. The third chapter reported the synthesis of nanocomposites of PLA with ZnO@HNT by using an ultrasound-assisted solvent casting method. The nanocomposite film PZH2 (consisting 2 wt% ZnO@HNT) showed the best properties compared to PLA. Moreover, a packaging test was performed on cut apples for 6 days storage period to evaluate the potential efficacy of nanocomposite films for food packaging

applications. In the fourth chapter, nanocomposites of PLA with clove essential oil (CEO) and alkali-treated l nanotubes (NHNT) as fillers were synthesized. The treatment of halloysite nanotubes with NaOH increased the surface area from 50.16 $m^2 \cdot g^{-1}$ to 57.01 $m^2 \cdot g^{-1}$ and pore volume from 0.25 $cm^3 \cdot g^{-1}$ to 0.32 $cm^3 \cdot g^{-1}$. Incorporating CEO and NHNT improved the surface hydrophobicity, water vapor barrier properties, thermal stability and mechanical properties (mainly elongation at break) of the PLA-based nanocomposite films.