National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Fabrication of Nanostructure-Infused Biopolymeric Composite Film for the Application of Antibacterial Wound Dressing and Active Food Packaging
Speaker	: Sonali Mohanty (Rollno : 519bm1007)
Supervisor	: Subhankar Paul
Venue	: Offline. (Seminar Hall, Dept. Of Biotechnology & Medical Engineering)
Date and Time	: 27 Mar 2025 (4.30 p.m.)
Abstract	: Multifunctional biomolecule-based nanocomposite materials were developed for advanced wound dressings and biodegradable food packaging applications. Wound dressings were developed by coating cotton gauze with chitosan and functionalizing it with Ca-doped ZnO and curcumin (Cur@CaZnO) nanocomposites. The dressing exhibited potent antibacterial activity, against *B.subtilis*, *S.aureus, E.coli,* and *P.aeruginosa*. It also demonstrated strong antibiofilm effects, inhibiting 80% of *S. aureus* and 71% o f *E. coli* biofilm formation while disrupting over 70% of preformed biofilms. The Cur@CaZnO nanocomposite coating also provided pH-responsive real-time wound monitoring and improved mechanical flexibility to the pristine gauze. Biocompatibility assessments using L929 mouse fibroblast cells confirmed that nanocomposite reinforcement below 5 wt% was safe. A 2.5% nanocomposite-coated gauze promoted 96% L929 cell migration within 24 h, facilitating wound closure through enhanced fibroblast migration. The second part comprised the development of tranexamic acid (TRA)-infused chitosan-guar gum nanocomposite film (CGT/AgZnO) with 3 wt% Ag-doped ZnO nanoparticles (CGT/AgZnO3), exhibiting 90% and 94% bacterial inhibition against gram-negative and gram-positive bacteria, respectively. The films showed high biofilm inhibition, reduced blood clotting index (BCI), and enhanced wound closure, with 100% L929 mouse fibroblast cell migration within 24 h with excellent hemocompatibility and cytocompatibility. Further, a biodegradable food packaging film was fabricated by incorporating nano ZnO/N-doped nanoTiO$_2$ and eugenol (ZTE) into a chitosan-guar gum matrix (CG/ZTE). The optimized film exhibited 94% and 88% biofilm inhibition against *S. aureus* and *E. coli*, respectively. It also provided enhanced mechanical strength, UV shielding, and moisture resistance, while its photocatalytic activity under 450 nm visible light exposure resulted in complete bacterial inactivation within 30 min. The shelf-life of wrapped chicken fillets in CG/ZTE films was extended to 12 days as compared to 6 days for unwrapped fillets. The weight loss of the composite film was more than 50% in soil within 30 days. Overall, these studies confirmed the potential of biomolecule and inorganic nanostructure-based nanocomposite films as promising solutions for bacterial protection, biofilm inhibition, wound healing, and sustainable food packaging, paving the way for enhanced biomedical and food safety applications.