INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	**DOLI HAZARIKA**
Roll Number	:	**176107021**
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Thesis Title: **Studies on Functionalization of Poly(lactic acid) for Textile Applications**

Name of Thesis Supervisor(s)	:	**Prof. Vimal Katiyar and Dr. Amit Kumar**
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SHORT ABSTRACT

The idea of a sustainable environment has led to a path to reduce utilization of fossil fuel-based petroleum products. Enough evidence shows that synthetic fibers, and other plastics do not degrade fully in waste water treatment plants, landfills, and the environment. Sustainable polymers have facile degradation pathways and, in many cases, can be obtained from renewable resources, making them promising alternatives to conventional plastics. Poly(lactic acid),(PLA) is one of the most widely studied sustainable polymers that possess several properties that are comparable to conventional polymers. The present work is a systematic, descriptive study of PLA-based composites in the field of textiles. The reinforcement phase of textile materials developed in this work consists of hybrid materials with modified structure and shape such that resulting products are non-toxic, ecological, and biodegradable. Material selection while designing sustainable products also plays an important role in the engineering field. The hybrid materials are a combination of two materials (organic and inorganic) that can offer benefits to

conventional textiles with functional characteristics in order to develop smart textiles for waste water treatment as well as healthcare applications. The combination of organic and inorganic parts deals with both strong (covalent, ionic covalent bond) and weaker (hydrogen, electrostatic, and van der Waals force) interactions. Nanotechnology in textile design is currently based on electrospun polymeric nanofabric to obtain functional properties like high hydrophobicity, high hydrophilicity, self-cleaning ability, dye degradability, shrinkage free characteristic, shimmer, antibacterial, and antiviral properties. The smart components are added to the substrate during fiber spinning, fabric formation level, or during finishing level. PLA functionalization has been carried out by in situ incorporation of nanohybrid fillers during polymerization followed by electrospinning to obtain the multifunctional properties for application in waste water treatment for a sustainable environment. The thesis also discusses the functionalization finishing approach by obtaining a polymer-hybrid composite solution where electrospun fabric is impregnated into this solution for application in the the healthcare sector. The choice of a hybrid solution will lead to a shimmery nanofinish layer over electrospun PLA nanofabric to tune the properties. Further, for PLA nanofabric, as the big challenge is to achieve dyeing, stability, and superhdrophilicity, the introduction of stereocomplexity on subsequent annealing can be a novel approach using nano-metal oxide to overcome such problems. The modification of crystallization behaviour of highly hydrophobic PLA nanofabric by the incorporation of nanohybrid fillers into the electrospun solution has also been investigated in this work. The presence of biopolymer nanocrystals with metal oxide acting as nucleating agent results in the change in crystallization behaviour.

Another fact lies on proper disposal of PLA under specific environmental conditions is important along with its high-cost production during monomer formation. In this thesis, we report another

pathway for degradation of PLA using a hybrid catalyst that can reduce the environmental disposal as well as energy and material input during their production. Here, we have demonstrated the capability of the hybrid catalyst for the production and degradation of PLA.

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