# INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
## SHORT ABSTRACT OF THESIS

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| Programme of Study | : | Ph.D. |
| Thesis Title | : | Studies on Poly (Lactic Acid)/Chitosan based Bioresorbable composites for Orthopaedic Applications. |
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| Thesis Submitted to the Academic Division | : | Department of Chemical Engineering |
| Date of completion of Thesis Viva-Voce Exam | : | 27/11/25 |
| Key words for description of Thesis Work | : | Bioresorbable, Polylactic acid, Hydroxy apatite, Chitosan, Finite Element Analysis, Orthopaedic implants. |


### SHORT ABSTRACT

The ageing global population, coupled with an increasing number of trauma cases such as accidents and sports injuries, has led to a higher incidence of bone fractures. These fractures require immediate medical attention, often in the form of orthopaedic surgery that involves implanting external or internal fixation devices. The choice of internal fixation devices, such as bone plates, screws, and pins, depends on the severity of the injury and the location of the fracture.

While conventional metallic fixation implants provide stable initial post-operative support for fractured bones, allowing for early mobilisation, they come with certain drawbacks. These include the dissolution of metallic ions, which can accumulate in local lymph nodes and other organs, the stress shielding phenomenon, and the generation of artefacts on computed tomography (CT) scans. Consequently, patients often require secondary surgery to remove the metallic implants after the fracture has healed, resulting in a more invasive procedure that increases the overall socio-economic burden on patients.

An alternative solution is to replace conventional fixation devices with bioresorbable polymer systems, whose properties can be customised to match those of natural bone. Once implanted, these bioresorbable implants break down into harmless by-products that are eventually eliminated from the body, thereby allowing the host tissue to replace them. This approach eliminates the need for revision surgeries and addresses the limitations associated with traditional implants.

The current study found that adding modified chitosan (MCS) and hydroxyapatite (HAp) to a Polylactic acid (PLA) matrix significantly enhances the load-bearing capacity and bioactivity of the implants. Various analyses, including surface morphology, differential scanning calorimetry, contact angle measurements,

thermogravimetric analysis, Fourier transform infrared spectroscopy, and mechanical strength testing, were conducted to examine the characteristics of the prepared bio- composite.

The interaction between nHAp, MCS, and PLA made the synthesised bio-composites superior in terms of chemical properties and mechano-thermal stability compared to neat PLA. Contact angle studies demonstrated improved surface wettability, indicating that the bio-composites are suitable for cell proliferation. Additionally, the incorporation of nHAp increased Young's modulus without causing phase separation.

Moreover, in silico studies using Finite Element (FE) analysis were employed to assess the suitability of the PLA-based composite as an implant material for low-load-bearing fracture fixation devices. For high load-bearing fracture sites, the fabricated bio- composite was applied as a coating over conventional metallic implants. Cytotoxicity studies confirmed the nontoxic nature of the bio-composite on mouse fibroblast cell lines, even at higher concentrations.

In future applications, the bio-composite developed in this study could be utilised for in situ drug delivery, facilitating specific treatment strategies in bone healing. Consequently, these bio-composites hold great potential as an alternative biodegradable implant material, particularly for creating biomedical implants like bone screws and plates.