



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Design and development of antimicrobial and biocompatible model implant surfaces: Bio-interfacial interactions

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SHORT ABSTRACT

A modern sedentary lifestyle and an aging population have weakened the immune response to various diseases and increased bone brittleness. So, bone damage has increased many folds, leading to augmentation of the damaged parts with biomaterial-based implantation. The cost of biomedical implants is increasing with time, and inversely, the success rate of the implants is decreasing. Implants, particularly orthopedic implants, lack blood vessels on the surfaces, making it impossible for immunological agents to eradicate bacterial contamination at the implant surface. This necessitates heavy antibiotic administration to prevent bacterial contamination and, thus, sepsis at the site. This might lead to the development of antibiotic-resistant bacterial strains and other side effects. Biomaterials suffer stress shielding, micromotion, biofouling, lesser biocompatibility, and surface leaching compared to natural bone. Surface phenomena govern implant interactions with the physiological microenvironment; thus, tuning the surface properties using various chemical and physical modification strategies can enhance the overall implant properties. In this work, silane-based Self Assembled Monolayers (SAMs) with various chain lengths and terminal moieties were fabricated on the model implant surfaces (silica, titanium, and Ti6Al4V) to enhance the biocompatibility, modulate the protein adsorption behaviour with antimicrobial surface coatings. Silane SAMs were fabricated on the model implant surfaces (silica and titanium alloy) with variable SAMs lengths and diverse terminal groups such as amine-, octyl-, hybrid-, carboxyl-, hexadecyl- and octadecyl- on the surfaces. Surface properties insights were investigated by altering surface hydrophilicity and surface energy. The change in the peak area of the various functional groups (elucidated by FTIR) on the SAMs surface also explored surface behaviour. Surface parameters were correlated with the thickness of the SAMs functionalities, giving valuable insights regarding surface tunability. Surface behavior regarding the nature of the protein adsorption (protein-biomaterial) was also explored. Change in the protein secondary structure due to the formation of the contact points with the surfaces were investigated to tune the protein adsorption behaviour as the nature of the protein adsorbing to the surface determines the implant fate. In the initial studies, Bovine Serum Albumin (BSA) was explored as the model protein for the adsorption studies on silane-modified surfaces. Fetal Bovine Serum (FBS), a cocktail of various physiological proteins, was also explored for the adsorption behaviour on the functionalized surfaces along with other blood proteins (collagen and fibrinogen). The

degree and the nature of the conformational changes determined the efficacy of the said fabrications in the physiological microenvironment. Cell adhesion behaviour of the osteoblast cell line (MG63) with the functionalized materials (cell-biomaterial interactions) was also investigated. Various cell adhesion parameters (surface coverage, average cell area, and circularity index) were quantified to get a deeper and broader insight into cell adhesion behaviour. Moreover, the cell adhesion studies were clubbed with the protein pre-adsorption (FBS, Collagen, fibrinogen, and BSA) to investigate the behaviour in simulated physiological conditions and to explore the potential of the various proteins for surface coating applications. Fabrication of antimicrobial and anti-biofilm coatings on the silane SAMs functionalized surfaces was carried out. Biogenic AgNPs were explored as the anti-biofilm coatings against *Pseudomonas aeruginosa*. Also, chitosan (biopolymer) was utilized as the antimicrobial agent and drug-loading vehicle for ampicillin against the clinically relevant bacterial strains (*Escherichia coli* and *Staphylococcus aureus*) on functionalized surfaces. This doctoral work investigated the surface tunability of model implant surfaces using various silane moieties to modulate protein adsorption behaviour and enhance cell adhesion nature with antimicrobial coating fabrication.

