Synopsis Seminar

Seminar Title	: Development of bulk nanostructured materials for medical implants using severe plastic deformation techniques
Speaker	: Moumita Ghosh (Rollno : 519bm1010)
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Venue	: BM Seminar Room (Room No.: BM 140), BM Dept
Date and Time	: 03 Jan 2025 (4.00 pm)

Abstract

: Commercially pure titanium (Cp-Ti) is widely regarded as an ideal material for biomedical implants due to its low Young&rsquos modulus, exceptional biocompatibility, and corrosion resistance. However, its relatively low strength compared to alloys limits its suitability for load-bearing applications. This research addresses this limitation by developing bulk nanostructured Cp-Ti using severe plastic deformation (SPD) techniques, including Equal Channel Angular Pressing (ECAP), Repetitive Corrugation and Straightening (RCS), and Ball Milling (BM). Comprehensive characterization using advanced techniques such as SEM, TEM, XRD, and mechanical testing demonstrated that SPD significantly enhanced Cp-Ti's mechanical strength, bioactivity, and biocompatibility, making it ideal for orthopedic applications. The average grain size of ECAP (4-pass) and RCS (12-pass) samples was reduced to 25.7 µm and 5 µm, respectively, resulting in significant improvements in mechanical and bioactivity properties. Hardness and tensile strength increased by 31.32% and 44.70%, respectively, compared to as-received samples. Hydrophilicity improved with decreasing contact angle, leading to enhanced surface energy, protein adsorption, and apatite formation on simulated body fluid-immersed samples with a Ca/P ratio of ~1.67. This promoted better osteointegration, faster wound healing, and improved implant acceptance. Hemocompatibility studies showed that all processed samples exhibited a hemolysis percentage below 5%, indicating high compatibility. In-vitro cell viability, mineralization, and cytotoxicity assays demonstrated improved biological performance. Confocal microscopy revealed increased MG-63 cell proliferation over time, with enhanced osteogenic differentiation and matrix mineralization, making the material suitable for orthopedic applications. Ball-milled Cp-Ti and Cp-Ti/HA composites showed structural and biological improvements. XRD analysis revealed peak broadening with milling time, while DLS indicated reduced particle size. Composite samples exhibited superior bioactivity, protein adsorption, and osteointegration due to the addition of hydroxyapatite. This study demonstrates that nanostructuring Cp-Ti through SPD techniques significantly enhances its mechanical, bioactivity, and biocompatibility properties, making it an ideal candidate for orthopedic implant applications.