Development of Zinc based biodegradable material with improved mechanical and degradation properties

Dayanidhi Krishna Pathak
PhD Scholar, Mech Engg Dept, IIT Delhi

The work focuses on developing Zinc-Hydroxyapatite (HA) and Zn-Hydroxyapatite-Iron (Fe) biodegradable materials (BMs) by making the use of powder metallurgy (PM) technique with microwave sintering. Response surface methodology was used to plan the experiments to determine the effect of PM process factors on compressive yield strength and sintered density of Zn-HA BM and the optimum factors were obtained using multi-objective optimization. The experimental results revealed that the developed materials possessed the mechanical properties within the range of human cortical bone. The corrosion mechanism of Zn-HA and Zn-HA-Fe BMs was determined using the simulated body fluid (SBF) solution at 37 ℃. The corrosion rate of the developed materials was also found to conform to the degradable requirements of an implant. The in vitro cytocompatibility (indirect MTT) and hydrophilicity of the developed Zn based BMs unveiled the substantial non-toxic behavior of the prepared samples exhibiting good biocompatibility. Furthermore, modelling based on electrochemical impedance spectroscopy study and mathematical correlation were proposed to predict the corrosion degradation kinetics and corrosion rate of developed Zn based BMs, respectively. Validation of the developed model with the experimental values resulted in good agreement with the predicted values with 9.63% as the maximum error. From the study, it was concluded that the developed Zn based BMs exhibited favorable properties which may be tuned to suit the appropriate biomedical application.