Abstract:

The orthopaedic implants for the human body are generally made of different metals. The inconsistent growth of tissues and poor osteoconduction performance on the metallic implant surfaces due to the variation of surface energy are major contributing factors for failure of the most metallic implant on account of lack of stronger attachment with surrounding bone or tissues.

Keeping in view of this, this study aimed to develop a thin bio-functional composite coating over the metallic implant surface through electrochemical deposition from aqueous electrolyte bath. It is observed that pulsed mode deliver optimum results in terms of surface morphology and corrosion protection performance. Also, nucleation rate vis-à-vis cathode current density plays an important role to determine the overall coating crystallinity, relative phase presence and internal stress generation in the coating surface. The formation of hydroxyapatite took place through a two-step reaction with the formation of calcium orthophosphate in between. Different shape and structure of apatite formation are evident starting from submicron spherical scaffold along with 100-150 nm pores on its surface to lamellar interconnected 3D scaffolds during osteoconduction based on the coating surface physical and chemical properties. The coating comes with around 67% of hydroxyapatite gives best results.

Various carbon nano structure and polymer reinforcement in the composite coating further improved the coating stability as compared to collagen fiber in natural bone. The chlorophyll functionalization showed a smart way to disperse the nano size reinforcement particle in the aqueous bath without damaging their chemical structure and thus ensure co-deposition side by side with in-situ formed calcium phosphate phases in order to ensure a better bonding with the composite. The polymer-ceramic composite coatings are achieved for the first time through a specially designed pulse reverse deposition techniques, exhibits modulus of elasticity near to natural human bone.

Laser surface processing and laser cladding are adopted in this study for tiny tailor made implant surfaces which require multiple surface prepositions along with varying modulus of elasticity based on specific requirement. Synthesis of nickel free titanium-calcium phosphate clad layer gives superior corrosion resistance and improved modulus of elasticity without altering the base material performance.