ICAM2009

11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

Hydroxyapatite Coating for Fixation of Biomedical Implants

K. L. Yadav(1)* and Aarti Mehta(2)

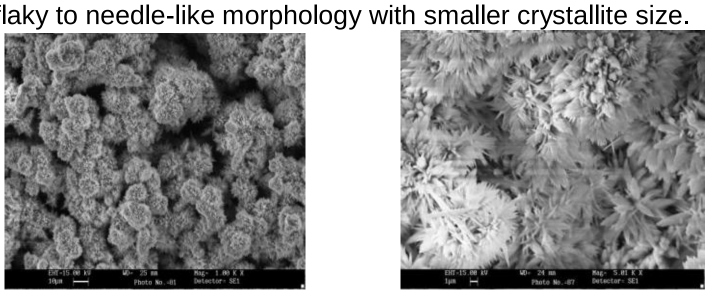
(1) Smart Materials Research Laboratory, Department of Physics, Indian Institute of Technology Roorkee, Roorkee-247 667, India. Email: klyadav35@yahoo.com

(2) National Physical Laboratory, New Delhi, India. Email: aks302117@gmail.com

* Corresponding author.

Abstract – In the present work a unique chemical method for the deposition of hydroxyapatite(HAp) coating on Stainless steel substrate is described. A chemical bath was prepared for hydroxyapatite coating. The chemical bath deposition was performed in a 50 ml beaker by immersing the steel plate in the prepared solution. Phase purity was confirmed by X-ray Diffraction (XRD) and Fourier transforms infrared (FT-IR) spectroscopy. Scanning electron micrographs (Fig. 1) of HAp after the completion of coating at 95 ^{o}C appears in flaky to needle-like morphology with smaller crystallite size.

Hydroxyapatite (HAp) forms the main mineral constituent of human hard tissues and its biocompatibility makes it attractive for use in medical devices [1,2]. It is one of a limited number of materials that forms strong chemical bonds with bone in vivo, while remaining stable under the harsh conditions encountered in the human body. These properties place hydroxyapatite into the class of biomaterials known as surface active or bioactive materials. Most metallic orthopaedic and dental implants are bioinert and do not bond chemically to bone as does hydroxyapatite. Consequently they can become encapsulated by fibrous tissue. Thus, the only means of biofixation is mechanical interlock, whereby the implant must be manufactured in such a way that it possesses surface porosity with interconnections and pores so that hard tissue can grow into the implant and anchor it in place. If the implant does not integrate well with the surrounding bone, or is not held rigidly with a fastening device, the implant will be subjected to micro-movement, and surrounding bone will remodel. This may lead to implant loosening over a period of time. Coating a load bearing substrate, such as titanium metal, with HAp overcomes the physical inadequacies of HAp. The main goal is to accelerate bone ingrowth's to implant surface and thus fixation of the prosthesis. Coatings of hydroxyapatite have been done by a variety of techniques that suffer from various drawbacks which will be discussed during presentation of the paper. Pure HAp coatings are necessary for medical implant because other phases and constituents could accelerate the degradation of HAp coatings in the human body. In the present work a unique chemical method for the deposition of hydroxyapatite coating on Stainless steel substrate is described. A chemical bath was prepared for hydroxyapatite coating. The chemical bath deposition was performed in a 50 ml beaker by immersing the steel plate in the prepared solution. Phase purity was confirmed by X-ray Diffraction (XRD) and Fourier transforms infrared (FT-IR). SEM micrographs of HAp after the completion of coating at 95 ^{o}C are shown in Fig. 1(a-b). The HAp formed is of flake like morphology. The HAp formed appears in flaky to needle-like morphology with smaller crystallite size.



(a) (b)

Figure 1. SEM micrographs of HAp

The described method is very simple and produces stoichiometric hydroxyapatite coatings with Ca/P=1.67. It can be applied for deposition onto complex shaped implants. Note that the deposition temperature is below 100 ^{o}C with potential for deposition onto polymer substrates. The method can be optimized by designed experiments to control the growth kinetics of stoichiometric HAp coatings. The dense fracture free coating with preferentially oriented grains can improve adhesion with the substrate and also act as a barrier layer between implant surface and body fluids preventing dissolution of the metal. These properties are appropriate for the initial layer in the bi-layer HAp coating designed to satisfy the essential requirements considering its application as a surgical implant material. Results will be discussed in details at the time of presentation.

References

[1] K. L. Yadav and P. W. Brown, J. Biomed. Mater. Res., **65A** (2003)158-163

[2] C. P. A. T. Klein, P. Patka and W. Den Hollander, "Handbook of Bioactive Ceramics", Vol. II edited by T. Yamamuro, L. L. Hench and J. Wilson (CRC Press, Boca Raton, FL) (1990), p-53