ABSTRACT

The advent of porous coatings for joint replacement prostheses has proven to be a remarkable innovation in the field of orthopedics. These coatings allow for biologic fixation of implants to host bone via ingrowth into the integrated porous structure. The ability of bone to remodel around cementless prostheses may attribute to enhance long-term success with these components. The impetus to develop porous materials initially arose from concerns regarding late aseptic loosening found with cemented hip replacements. Over time, the field of porous biomaterials has continued to advance. Porous metallic coatings on cementless femoral stem for improved osseointegration have gained momentum since last two decades. Implant fixation enhanced by porous structures is still under intensive study, after more than 30 years of development. In this thesis work, the focus is on studying and subsequently developing a porous titanium coating method called Inert Gas Electric Arc spray (IGEA) on Titanium alloy (Ti-6Al-4V) cementless femoral stem which has been earlier designed at IIT Delhi based on Indian anthropometric data.

The preliminary investigation of the Inert Gas Electric Arc (IGEA) spray process have done on samples prepared as per ASTM standard C-633 and F-1044. The morphological characterization was done using optical techniques with scanning electron microscope (SEM) images and X- ray diffraction (XRD) technique. The mechanical characterization was done on the samples to find the strength of the coating in tensile, compressive and bending load. The detail morphological investigation for the porosity and pore size were done considering important spray parameters like power, stand-off distance and wire feed rate of the electric arc spray process. The detail mechanical characterization of the coating considering bond strength, lap shear strength were done using the same parameter of the process used in morphological characterization.

The corrosion and biocompatibility study of the produced coating on the samples were done using spray parameters like power, stand-off distance and wire feed rate of the electric arc spray process. The Finite element analysis (FEA) of the proximally coated femoral stem was done to prove the better load transfer with electric arc spray porous coating than uncoated femoral stem to minimize the stress shielding in *in-vivo* condition.

This study provide design and development of femoral stems based on the anthropometric data of the Indian population. This research work has led to the development of newer affordable technique for titanium porous coating which can promote better osseointegration and reduce micromotion and stress shielding. The developed titanium porous coating can open new and affordable ways of porous coating for biomedical applications and also it can mimic trabeculae bone morphology with reduced modulus.