Contribution ID: **361** Type: **Invited talk**

Hydroxyapatite and Ceramic Composite Coatings by Novel Plasma Spraying Technology for Bio-Medical Implant Application

Wednesday 20 May 2015 15:30 (30 minutes)

Hydroxyapatite (HA) coated implants have promising bioactive properties and biocompatibility of HA with bone in orthopedic and dental surgery. The advantages of HA coating on implants is those, such as a more rapid and stable fixation of the implant to the bone, stronger bonding between the bone and the implant, increased uniform bone in growth at the bone implant interface and decreased release of metal ions from the implant to the body, etc. The plasma sprayed HA coatings generally contain cracks, pores, second phases, and residual stresses. Those affect the in-vivo performance of HA coatings due to both composition and crystallinity. Therefore, the control of the micro-structure of the HA coatings is the main target to develop the high performance implants for bio-medical applications.

The gas tunnel type plasma spraying developed by the author is a novel plasma technology, which has properties such as high thermal efficiency of 80%, high temperature and high energy density, relatively high deposition rate, prevention of in-flight decomposition, minimized oxidation due to higher amount of working gas, and so on. Therefore, the gas tunnel type plasma spraying enables to obtain not only high quality ceramic coatings, but also HA coatings in a short spraying time. By observation of SEM micrographs of HA coatings sprayed at different arc current, the pores appeared in the HA coating sprayed at low arc current, and HA coating became high dense with few pores at high arc current. This means the good controllability of the microstructures of HA coatings by this novel plasma spraying method. Crystalline HA coating was achieved through gas tunnel type plasma spraying under optimum spraying conditions.

Furthermore the gas tunnel type plasma spraying method was successfully employed to produce HA and YSZ reinforced HA coatings on 316L stainless steel substrate. The reinforcement of YSZ in HA significantly reduced the porosity and consequently increased the coating hardness and enhance the adhesive strength. The potentiodynamic polarization and impedance measurements showed that YSZ reinforced HA coatings have superior corrosion resistance compared to the pure HA coating in SBF solution. The cell culture results revealed that the reinforced YSZ coating has improved the bioactivity of the HA coatings. As another method to enhance the HA coating performance, lanthanum oxide (La2O3) was mixed with Hydroxyapatite (HA) powder. The addition of La2O3 in HA significantly reduced the porosity and consequently increased the coating hardness and enhanced the adhesive strength and wear resistance.

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Session Classification: Biological Physics and Biomedical Engineering (Sponsored by MTEC)

Track Classification: Biological Physics and Biomedical Engineering