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Dissolution Behaviors of Thermal Sprayed Calcium Phosphate Splats in Simulated Body Fluid

K.A. Khor[1], H. Li[1] and P. Cheang[2]

[1] School of Mechanical and Production Engineering, Nanyang Technological University, Nanyang Avenue, Singapore 639798, mkakhor@ntu.edu.sg

[2] School of Materials Engineering, Nanyang Technological University, Nanyang Avenue, Singapore 639798

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Abstract. This study aims at revealing the dissolution behavior of individual calcium phosphate (CP) splats after incubation in simulated body fluid (SBF) over various periods. The CP splats were prepared using both plasma spraying and high velocity oxy-fuel (HVOF) technique. The *in vitro* dissolution rates (defined here as the ratio of dissolved area to overall area of a splat) together with the morphological changes of the splats indicated that the extent of hydroxyapatite (HA) transformation to other CP during plasma spraying was more extensive than during HVOF spraying. It was found that 2 hours of *in vitro* incubation resulted in complete dissolution of the plasma sprayed CP splats; whilst the dissolution rate of the HVOF sprayed CP splats significantly depended on the melt states. For fully melted HVOF splats, complete dissolution occurred after 4 hours' incubation. The present results further confirmed that HA decomposition predominantly occurred within the melted part of the sprayed particles. In other words, there could be a relationship between melt states of HA particles during the spraying and phase composition of the resultant splats. The temperatures of the sprayed HA particles were also measured before their impingement on the titanium alloy substrates prior to forming splats.

Introduction

Calcium phosphate (CP) coatings deposited on titanium alloy implants have shown promising effects on rapid bone remodeling and suitable functional life in orthopedic and dental applications. It has also been recognized that precipitation of a bone-like apatite layer on the CP matrix *in vitro* was directly related to dissolution of the phases within the coating. In order to understand the *in vitro* behavior of the coatings, the clarification of their dissolution behavior is essentially required. To date, it was claimed that different phases within the CP family exhibited distinctive different structures, and thus, could lead to varying biological responses in simulated body fluid (SBF) [1]. The dissolution rate of monophasic CP ceramics increases in the following order: HA<CDHA<OHA<β-TCP<α-TCP<TTCP [1]. Furthermore, the influence of crystallinity of HA coatings has been clarified through *in vitro* test by immersing HA coating with miscellaneous amorphous calcium phosphate (ACP) content in SBF [1,2]. However, due to the high temperatures attained by the HA powders during thermal spraying, phase composition of the coatings is heterogeneous, which makes precise characterization of the dissolution elusive. Conversely, thermal sprayed coating composed of a layered structure, which is effectively an accumulation of individual solidified splats. Researchers have extensively conducted the study on thermal sprayed splats [3-5]. Generally, splat formation is an isolated event, which means minor influence would be exerted by the subsequent splat on the phases of the prior deposited splat. Therefore, the overall *in vitro* behavior of a bulk HA coating should be directly related to that of individual HA splats. A good understanding of the *in vitro* behavior of a single HA splat would significantly contribute to the knowledge on dissolution/precipitation mechanism of HA coatings. In the present study, the dissolution behavior of individual CP splats *in vitro* was characterized. The splats were deposited using both plasma spraying and HVOF onto polished Ti-6Al-4V substrates.