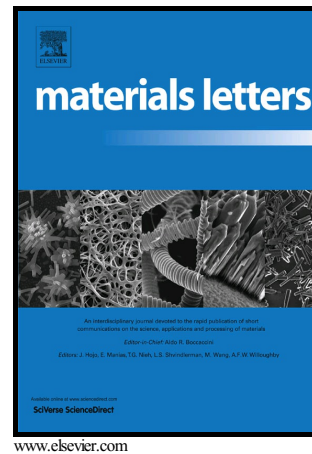


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# Synthesis and characterization of alumina-fluorapatite coatings deposited by atmospheric plasma spraying

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**Abstract:** In this work, the effect of an alumina ( $\text{Al}_2\text{O}_3$ )-fluorapatite (Fap:  $\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2$ ) composite coating on 316 L stainless steel was investigated. Only a small amount of fluorapatite (6.68 % Fap corresponding to 0.25% fluor) was introduced into alumina using a mixture of powders to increase the bioactivity of the coatings. The mixed powders were deposited onto 316 L SS substrates using atmospheric plasma spraying. The characteristics of the coatings were investigated with various methods including scanning electron microscopy (SEM), X-ray diffraction (XRD). The bioactivity of the  $\text{Al}_2\text{O}_3$ /Fap composite was evaluated by immersing the samples in simulated body fluid (SBF).  $\text{Al}_2\text{O}_3$ /Fap coating showed excellent behavior in vitro test revealing that the Fap is quite effective in improving biocompatibility.

**Keywords:** Fluorapatite; Alumina; Plasma Spraying; Simulated body fluid; Bioactivity.

## 1. Introduction:

Hydroxyapatite (Hap) and fluorapatite (Fap) constitute the inorganic basis of human hard tissues. Thermally sprayed Hap is widely used in orthopedic prostheses given its great potential in bone regeneration activity [1]. However, it has been reported that the high degradation rate of Hap coatings in biological environment remains a serious concern [2]. Previous research works have shown that the solubility of fluoro-hydroxyapatite (FHap) decreases with the increase in  $\text{F}^-$  concentration [3].

Thus, Fap has recently attracted some attention as an alternative to pure Hap coatings on metallic implants due to its chemical composition similar to the bone mineral [4], and therefore its excellent biocompatibility [5]. In fact, the human bone contains approximately 1wt% of Fluor [6] which is known as an effective element in inhibiting caries [7].

In this context, the present work is an attempt to investigate the potential interest of Fap- $\text{Al}_2\text{O}_3$  composite coatings. A considerable amount of research already focused on alumina coatings given its chemical stability and its high mechanical strength. Alumina has for a long time provided excellent bioinertia [8]. It is also one of the most widely investigated reinforcement materials for Hap bioceramics [9]. Meanwhile, considering the interesting bioactivity of Fap, it is surprising that, up to now, there has been very limited works on the synthesis and characterization of Fap- $\text{Al}_2\text{O}_3$  composite coatings.

The aim of the present work was to investigate a 6.68 w% Fap- $\text{Al}_2\text{O}_3$  coating deposited on a 316 L SS substrate using atmospheric plasma spraying (APS). The microstructural and biological properties of these Fap-alumina coatings are presented and discussed in order to determine their possible use as an implant material.

## 2. Materials and methods:

The Fap powder was synthesized using a wet-chemical method [10]. A calcium nitrate solution was slowly poured into a boiling solution containing di-ammonium hydrogenophosphate, and a 28%  $\text{NH}_4\text{OH}$  solution was added to the mixture in order to adjust the pH to 9. The precipitate was filtered and calcined at  $500^\circ\text{C}$ . The pure  $\alpha$ -alumina ( $\alpha$ - $\text{Al}_2\text{O}_3$ ) powder (Medicoat, 98.9 %) was used as base material. The powder mixtures were milled in ethanol. The mixtures were dried at  $80^\circ\text{C}$  for 24 h.

Pure  $\text{Al}_2\text{O}_3$  and  $\text{Al}_2\text{O}_3$ -Fap coatings were deposited on 316 L SS discs by APS using a Sulzer-Metco F4-MB (Switzerland) plasma gun mounted on an ABB-IRB2400 robot (Sweden). The plasma spray process parameters are listed in Table 1. The coating thickness was evaluated using a micrometer ( $250\ \mu\text{m}$ ).

Table.1. Plasma spray process parameters

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