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# Study of apatite deposition on several silicon nitride substrates

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**Abstract** ï In this paper, silicon nitride substrates were prepared with several rare earth oxides in order to be compared after deposition of apatite through biomimetic method. The results demonstrated this method was suitable since apatite deposition has been observed by SEM and DRIFT analysis. Also, differences in the layer morphology were detected and were related to the composition of silicon nitride substrates.

Different ceramics have been widely used as bioinert materials for clinical applications, mainly owing their excellent biocompatibility. However, the low fracture toughness of alumina[1] and high degradation of zirconia in biological medium[2] causes fractures in ceramic implants. Silicon nitride (SN) is a promising candidate to overcome this problem due to its unique properties, including a non-cytotoxicity character [3]. As a bioinert ceramic, it does not form chemical bonds with the living tissue, resulting in a bad fixation in the old bone [1]. However, it is proposed that SN with bioactive surface characteristic can be considered a biomaterial with excellent interaction with the living tissues, as well as great mechanical properties [4]. As SN sintering is clearly affect by rare earth oxide additions in terms on the densification, microstructure and mechanical properties, the objective of this investigation was to evaluate the effect of the composition of silicon nitride ceramics substrates on the deposition of apatite by biomimetic method.

SN samples containing 9 wt% additives ($Al_2O_3$, $Y_2O_3$, $La_2O_3$, $Nd_2O_3$, $Dy_2O_3$, $Yb_2O_3$), were obtained through pressing and sintering of high purity commercial powders. The microestrutural and mechanical analysis were performed in previous studies[5]. Sintered samples were coated with apatite using the biomimetic method. For that, SN rectified samples were exposed to sodium silicate solution (SS) at 37$^o$ C for 7 days. The samples were then washed in water, so that they could be immersed into 1.5 SBF. The samples were soaked in 1.5 SBF for 6 days at 37$^o$. SN surfaces were characterized by diffuse reflectance infrared Fourier transformed (DRIFT), X-ray diffraction (XRD) and scanning electron microscopy (SEM).

The XRD patterns showed only the presence of β-$Si_3N_4$ phase. However, SEM micrographs showed the apatite layer on the all studied surfaces, with some differences in regard to the morphology of the layer. The samples containing $Y_2O_3$ and $Yb_2O_3$ presented better results, with the coating characterized by a dense layer with dispersed globules (Fig. 1). Additionally, the presence of $PO_4^{3-}$ and $CO_3^{2-}$ groups were identified by DRIFT (Fig. 2), defined by bands 484, 456, 632 and 1532 $cm^{-1}$, suggesting the apatite deposition. Based on these results, it can be concluded that the biomimetic method promoted the deposition of a dense layer of apatite on SN surfaces. The morphology and the layer amount depend on the oxide used as SN additives.

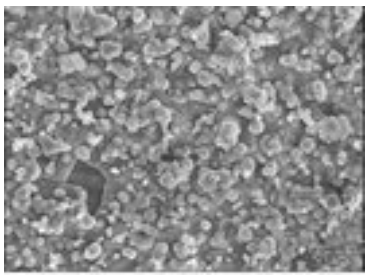

**Figure 1:** Typical SEM micrograph of the SN surface coated by the apatite layer

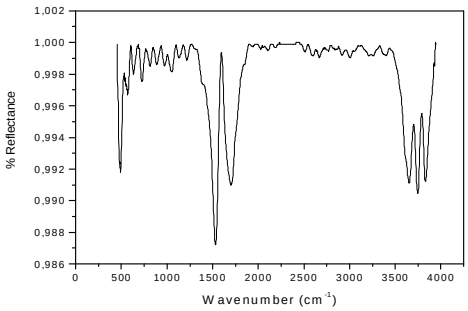


**Figure 2**: Typical DRIFT spectra of a SN sample with apatite coating

## References

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