ZnO-Hydroxyapatite nanocomposite porous coating synthesized by pulsed laser deposition: study by TEM and 3D FIB Tomography

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Hydroxyapatite (HA) has been widely applied as a coating material on metallic supports because they have the ability to induce bone regeneration and enhance biochemical interactions with biological systems, which promotes the regeneration of the bone. Nanostructured HA coatings offer the ability of modifying surface properties, even more, when they can generate a controlled porosity. On the other hand, it is known that the antibacterial activity of ZnO is affected by the morphology, structure, and size where ZnO NPs showed an enhanced biocidal effect. Therefore, combining HA NPs as a bioactive component with ZnO NPs as an antimicrobial agent may provide a superior composite coating for biomedical implants [1]. In this context, pulsed laser ablation technique was used for the synthesis of HA coatings. Depositions were performed using crystalline ZnHA targets at a background pressure of 1 Torr, laser wavelength of 532 nm and pulse laser energy of 300 mJ. The coatings were deposited on Si substrate at room temperature (HZ-1) and heated at 400 (HZ-2), 600 (HZ-3) and 800°C (HZ-4). All coatings were studied using XRD, FTIR, SEM and EDS techniques. The HZ-1 coating features 67% amorphous calcium phosphate (ACP) phase. SEM indicated that coating is rough and formed by spherical shapes with diameters between micrometers and nanometers. ACP NPs are the most populous with mean diameter D_{ACP}=25 nm and Ca+Zn/P=1.57 ratio. The temperature effect is observed in the HZ-4 coating, here the coating is porous, rough and crystalline indicating the phases of HA and ZnO, with D_{HA}=295 nm and D_{ZnO}=50 nm. A local study was performed on this coating; we prepared lamellas using FIB for analysis using TEM techniques. This work also shows that high spatial resolution 3D FIB data reconstructed via the segmented images is necessary for the determination of the spatial distribution of pores and ZnO NPs in the HA coating.

[1] Ori Geuli et al., ACS Appl. Nano Mater. 2 (2019) 2946-2957