In this work we discuss the synthesis and characterization of Ta, TaN and TaN/Ta thin films deposited on Ti and SS316L as novel biomaterials to enhance implant bone biocompatibility. An RF sputtering system (13.56 MHz-80W) was used for thin film deposition. Ta thin films were deposited under Ar atmosphere with a pressure of 6.5 Pa and TaN thin films were deposited using Ar/N₂ atmosphere with a N₂ partial pressure of 2%. In order to evaluate the bioactivity of the thin films a biomimetic method has been used. This consisted in the immersion of the coated materials in simulated body fluid (SBF), an enriched SBF in Ca and PO₄ (1.5 Ca and 1.5 PO₄) were used.

Thin Films were evaluated by High Resolution Scanning Electron Microscopy (HRSEM) and by Atomic Force Microscopy (AFM). The transverse sections of the deposited Ta, TaN and Ta/TaN films on Si, showed the typical columnar growth of PVD deposition techniques; a layer thickness of 300 nm each was obtained. The planar views of the bilayer Ta/TaN coatings deposited on Ti and on SS316L are shown in Fig. 1 and 2. It can be observed that the microstructure of the bilayer Ta/TaN is denser on Ti than on SS316L. The TaN is deposited first on the metal substrate and then the Ta layer is deposited on top to form the bilayer, therefore the microstructure of the first layer is affected by the nature of the substrate and probably directs the growing of the second layer in a different way. The grain size of Ta in the bilayer on Ti (60 nm) is smaller than on SS316L (120 nm).

The immersion of the different materials in SBF from one to six weeks resulted in a coating of HA crystals, with increased thickness depending on the immersion period. Fig. 3 presents AFM images of TaN on SS316L, after immersion in SBF 1 week and 3 weeks. It is observed that the samples essentially consist of homogeneous granular structures covering the surface, the average roughness of the surface decreases with immersion time in SBF.
Fig. 1: HRSEM micrograph planar view Ta/TaN/Ti

Fig. 2: HRSEM micrograph planar view Ta/TaN/SS316L

Fig. 3: AFM topographic image of TaN/SS316L A) TaN/SS316L Coating, B) TaN/SS316L Coating one week in SBF and C) TaN/SS316L Coating three weeks in SBF.