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The Creation of Calcium Phosphate Coating on Nitinol Substrate

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Abstract : NiTi alloys are widely used as implants in medicine due to their unique properties such as superelasticity, shape memory effect and biocompatibility. However, despite these properties, one of the major problems is the release of nickel after prolonged use in the human body under dynamic stress. This occurs due to oxidation and cracking of NiTi implants, which provokes nickel segregation from the matrix to the surface and release into living tissues. As we know, nickel is a toxic element and can cause cancer, allergies, etc. One of the most popular ways to solve this problem is to create a corrosion resistant coating on NiTi. There are many coatings of this type, but not all of them have good biocompatibility, which is very important for medical implants. Coatings based on calcium phosphate phases have excellent biocompatibility because Ca and P are the main constituents of the mineral part of human bone. This fact suggests that a Ca-P coating on NiTi can enhance osteogenesis and accelerate the healing process. Therefore, the aim of this study is to investigate the structure of Ca-P coating on NiTi substrate. Plasma assisted radio frequency (RF) sputtering was used to obtain this film. This method was chosen because it allows the crystallinity and morphology of the Ca-P coating to be controlled by the sputtering parameters. It allows us to obtain three different NiTi samples with Ca-P coating. XRD, AFM, SEM and EDS were used to study the composition, structure and morphology of the coating phase. Scratch tests were carried out to evaluate the adhesion of the coating to the substrate. Wettability tests were used to investigate the hydrophilicity of the different coatings and to suggest which of them had better biocompatibility. XRD showed that the coatings of all samples were hydroxyapatite, but the matrix was represented by TiNi intermetallic compounds such as B2, Ti2Ni and Ni3Ti. The SEM shows that the densest and defect-free coating has only one sample after three hours of sputtering. Wettability tests show that the sample with the densest coating has the lowest contact angle of 40.2° and the largest free surface area of 57.17 mJ/m2, which is mostly disperse. A scratch test was carried out to investigate the adhesion of the coating to the surface and it was shown that all coatings were removed by a cohesive mechanism. However, at a load of 30N, the indenter reached the substrate in two out of three samples, except for the sample with the densest coating. It was concluded that the most promising sputtering mode was the third, which consisted of three hours of deposition. This mode produced a defect-free Ca-P coating with good wettability and adhesion.

Keywords : biocompatibility, calcium phosphate coating, NiTi alloy, radio frequency sputtering.
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