COMPOSITE NiTi/MULTI-PHASE LAYERS FOR MEDICAL APPLICATION

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Introduction

Despite the good biotolerance of the NiTi alloy by humane organisms, studies on the surface functionalization of these alloys is being carried out. On the surface of the alloys, layers are formed, which form barrier against nickel migration and also enable faster osseointegration or contain antibacterial substances [1-3].
In presented work the multi-phase layers was created on the top of NiTi alloy for its potential use in medicine and/or veterinary.

Materials and Methods

Surface of a commercial NiTi shape memory alloy was covered with multi-layer in two steps. First, the NiTi alloys was oxidized using glow discharge technique. Next, the top of oxidized layer was covered by mixture, consisted of chitosan and silver, in one electrophoretical process (voltage: 20-60V; time: 60-120s).
Received multi-phase layers were studied by X-ray diffraction (X'Pert Pro diffractometer). Surface was observed by scanning electron microscope (JEOL JSM 6480).

Results and Discussion

X-ray diffraction patterns measured for as-received surface of NiTi revealed presence of the R-phase (FIG. 1). This phase is an intermediate one and appears as a first step in two-steps martensitic transformation, where the B2 parent phase transforms to the martensite B19'. Titanium willingly forms oxides due to its higher affinity for oxygen than nickel. The oxidation was done using glow discharge technique. The alloy surface has been cleaned, polished and prepared to deposition of the oxide layer. After processing, a thin layer of titanium oxide was formed on the surface. In order to confirm structure of the oxide, the X-ray grazing incidence beam diffraction technique was used.

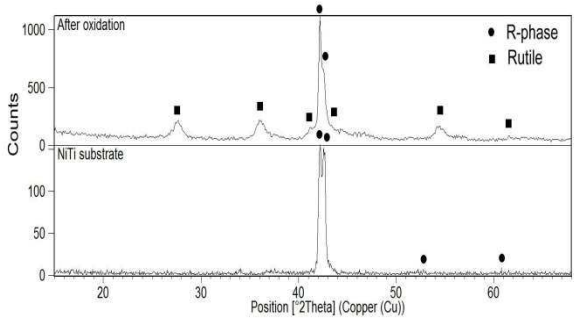

FIG. 1. Comparison of X-ray diffraction patterns measured for as-received NiTi alloy and after its oxidation.

Diffraction pattern measured at the constant incidence beam angle (0.5 deg.) showed presence of diffraction lines, which are representative for titanium oxides – rutile (ICDD card no 77-0441). Apart of that still the presence of the R-phase was stated (FIG. 1).
The oxidized surface of NiTi alloy was a substrate for deposition of a multi-phase layer containing chitosan and silver nanoparticles. FIG. 2 shows example of SEM image observed for NiTi surface after chitosan/silver layer deposition. The silver nanoparticles were well distributed and covered by chitosan.

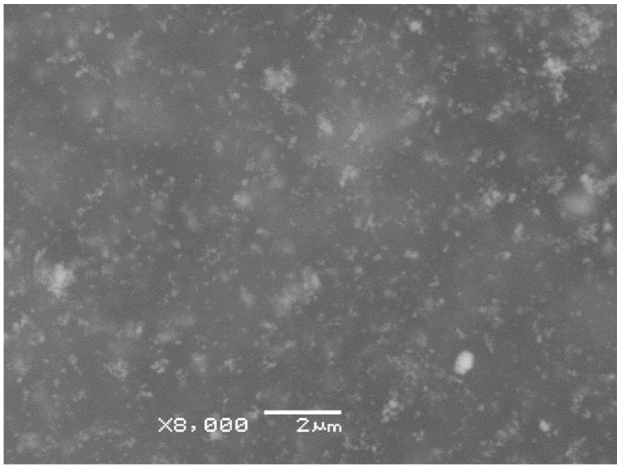

FIG. 2. SEM image observed from the top of modified surface of NiTi alloy after chitosan/Ag deposition.

The measured X-ray diffraction pattern, for a coated alloy with a chitosan/silver layer, contains diffraction lines characteristic for silver. In addition, the increased half-width of diffraction lines, representative for the silver, indicates that its nanometer size is maintained. The presence of chitosan, in the layer, confirms the anomaly of the background between an angle of 20 and 30 degrees. This effect, originating from the X-ray radiation scattering and indicates the amorphous nature of chitosan.

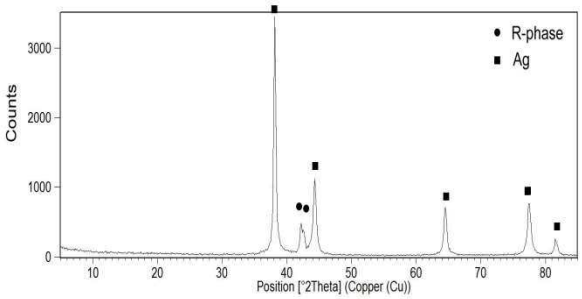

FIG. 3. X-ray diffraction pattern measured for oxidized NiTi alloy covered with Ch/Ag composite.

Conclusion

Combining the glow-oxidation technique with electrophoresis extends the ability to modify the surface of NiTi alloys for applications as a material for implants in medicine and veterinary medicine.

References

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