CHITOSAN/SILVER LAYER DEPOSITED ON NiTi SHAPE MEMORY ALLOY

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Introduction

The unique shape memory properties of the NiTi alloys make them one of the frequently used materials for medical application [1]. However, the remaining problem is their corrosion resistance due to the release of nickel, when they are applied in the biological environment. Attempts to improve corrosion resistance were primarily focused on the modification of alloy surfaces by the creation of protective layers/covers from: titanium oxides, titanium nitrides, hydroxyapatite, polylactide etc.
In the presented work, multifunctional approach to improvement of NiTi properties was done. The surface was cover with chitosan (CH) and silver composite. The silver is known from its antibacterial properties whereas chitosan can protect NiTi surface and follow deformation coming from the shape memory effect [3-4].

Materials and Methods

Commercial NiTi shape memory alloy was used as a substrate for CH/Ag layer production. On polished surface of the NiTi alloy, CH (Sigma Aldrich) simultaneously with Ag (AEE) was electrophoretically co-deposited using deposition voltage: 25, 30, 35 or 40V and deposition time from 60s to 120s.

Results and Discussion

Observations carried out with use of electron scanning microscope confirmed, that in all cases of deposition parameters, the surface of the alloy was covered with a thin layer composed of CH matrix with Ag as a composite component. Example of SEM images is shown in FIG. 1 and 2. In general, Ag particles were randomly distributed in the CH cover. Several of them formed agglomerates that protruded above the surface of CH. The diameter of the agglomerates increased with increasing of deposition voltage. Moreover, increasing deposition time and voltage resulted in the appearance of some discontinuities in the CH shell.

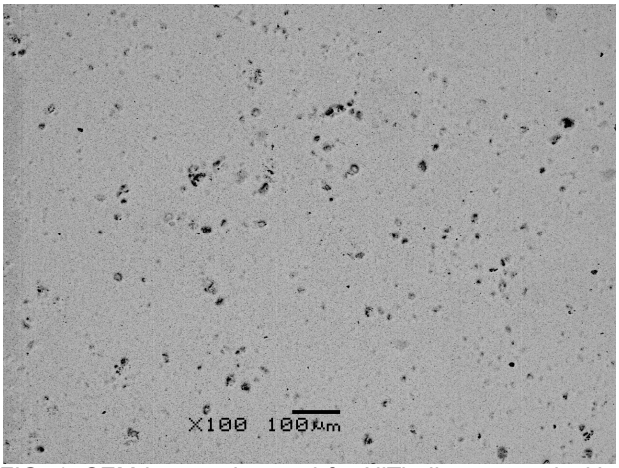

FIG. 1. SEM image observed for NiTi alloy covered with CH/Ag deposited at 25V/120s.

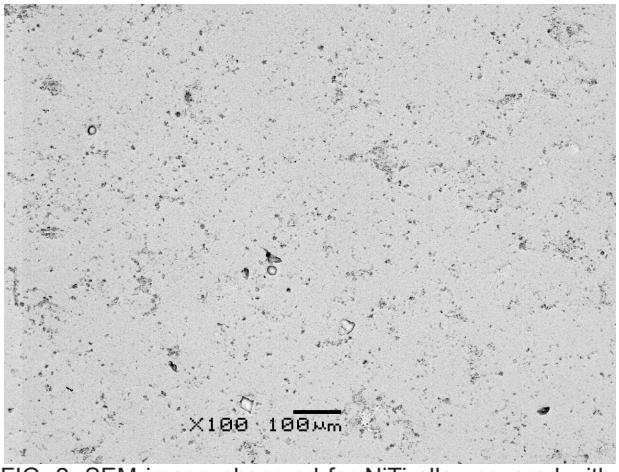

FIG. 2. SEM image observed for NiTi alloy covered with CH/Ag deposited at 40V/60s.

Structure of the cover was examined with use of X-ray grazing incident beam diffraction technique. Example of the measured diffraction patterns was shown in FIG. 3. Diffraction patterns measured at angle of 5 degrees revealed presence of lines belonging to Ag, mainly. The relatively high X-ray penetration depth revealed the presence of diffraction lines coming from the NiTi alloy substrate. Also, a widened maximum in the angular range of 15 to 25 degrees indicates the presence of CH in the amorphous form. Reducing the penetration depth of the x-ray beam (angle of incident beam was 0.3 deg) allowed to obtain the diffraction pattern only from the layer. Phase identification confirmed the presence of CH and Ag in the coating.

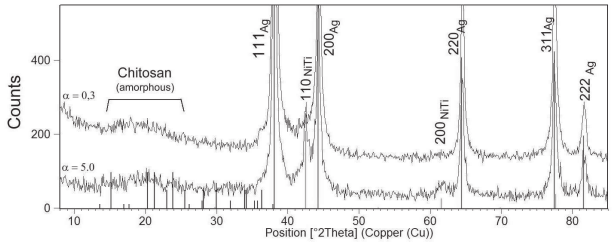

FIG. 3. GIXD patterns measured for NiTi alloy covered with CH/Ag at 40V/60s.

Conclusions

The increase in deposition voltage caused the formation of ever larger agglomerates consisted of Ag particles. Elongation of the time of electrophoretic deposition resulted in a discontinuity of the CH coating. This effect was especially visible on the edges of the sample.

References

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