16th International Invention and Innovation Show INTARG®
24-25 May 2023, Katowice - POLAND
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BIOCOMPATIBLE THIN FILMS BASED ON THIN METALLIC GLASSES USED IN ORTHOPEDY

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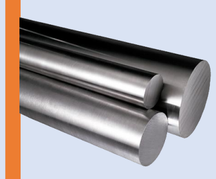
1. Abstract

Investigating ZrCu-based thin film metallic glasses as biomaterials for covering metallic orthopaedic implants was the aim of this study. ZrCu coatings with minor additions of Si, Mg, Ca, Sr, and Mo are used.

The films were deposited with a high deposition rate by cathodic arc method. The films were deposited on two distinct substates, including Ti6Al4V alloy and 316L stainless steel, both of which are frequently utilized for orthopaedic implants.

2. Materials & Method



316L stainless steel

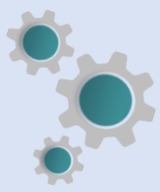
Ti6Al4V alloy

Coatings	Arc current
ZrCuCa	70 A
ZrCuMg	
ZrCuMo	
ZrCuSi	
ZrCuSr	

Substrate

Method

Cathodic arc deposition



Residual pressure 2×10^{-5} mbar

Bias voltage 100V

Working pressure 1×10^{-3}mbar

Argon flow 120 cm^3 /min

Parameters

SBF

8 h

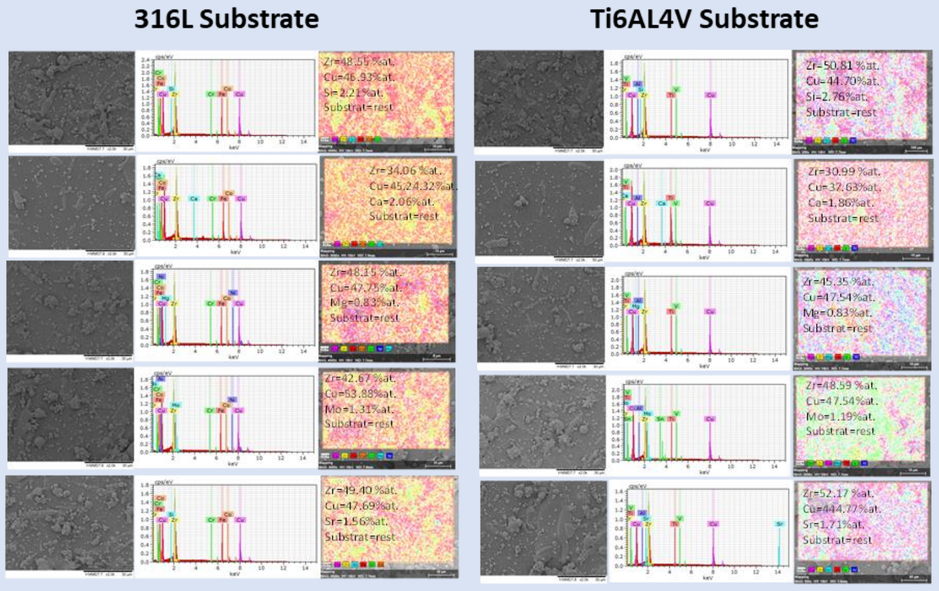
37 °C

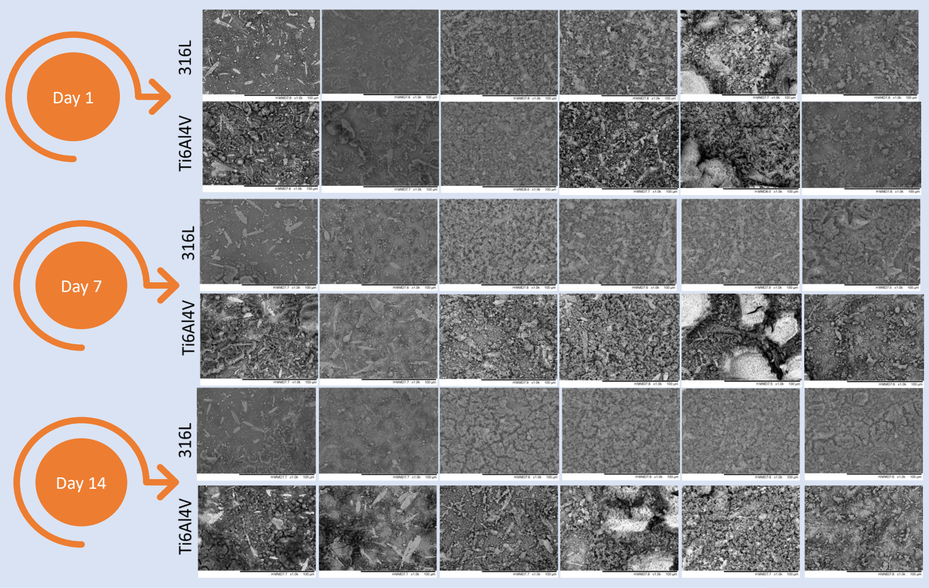
Characterization

1. Morphology + Elemental composition
2. Immersion tests
3. Roughness
4. Electrochemical behavior

3. Results & Discussions

The elements of the coatings were uniformly distributed on the whole investigated surfaces.

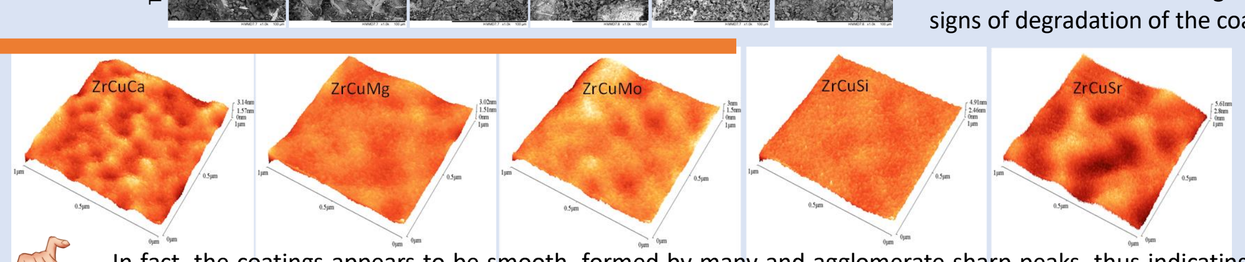




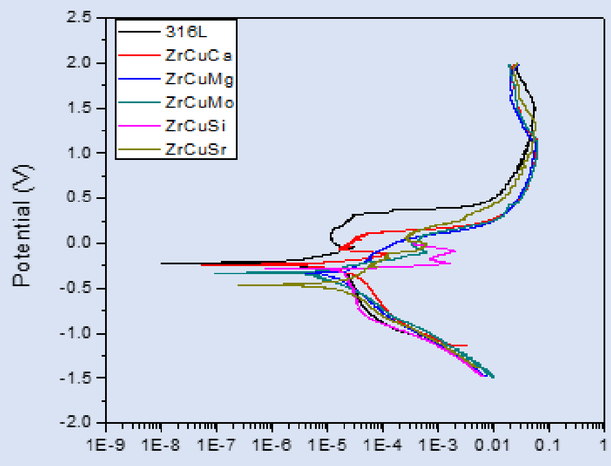
After corrosion tests

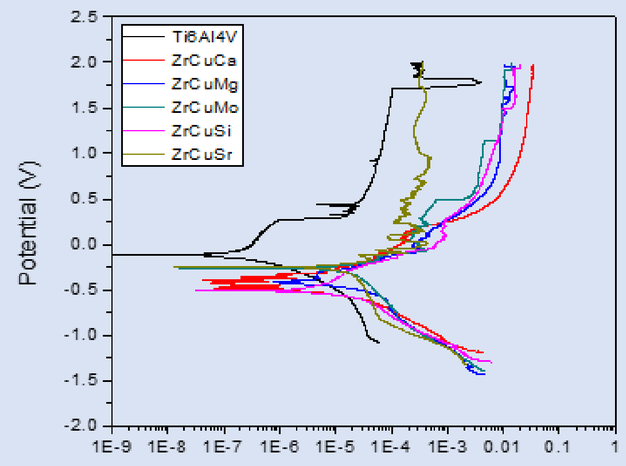
According to the SEM data, the cracks can be seen on the surface both coatings, being more evident in the case of those on 316L substrate. EDS mapping also showed that there is more amount of elements of coatings on the surface with Ti6Al4V.

All samples present newly apatite structures formed on their surfaces. For the coatings deposited on 316L, it can be observed that there are significant signs of degradation of the coating.



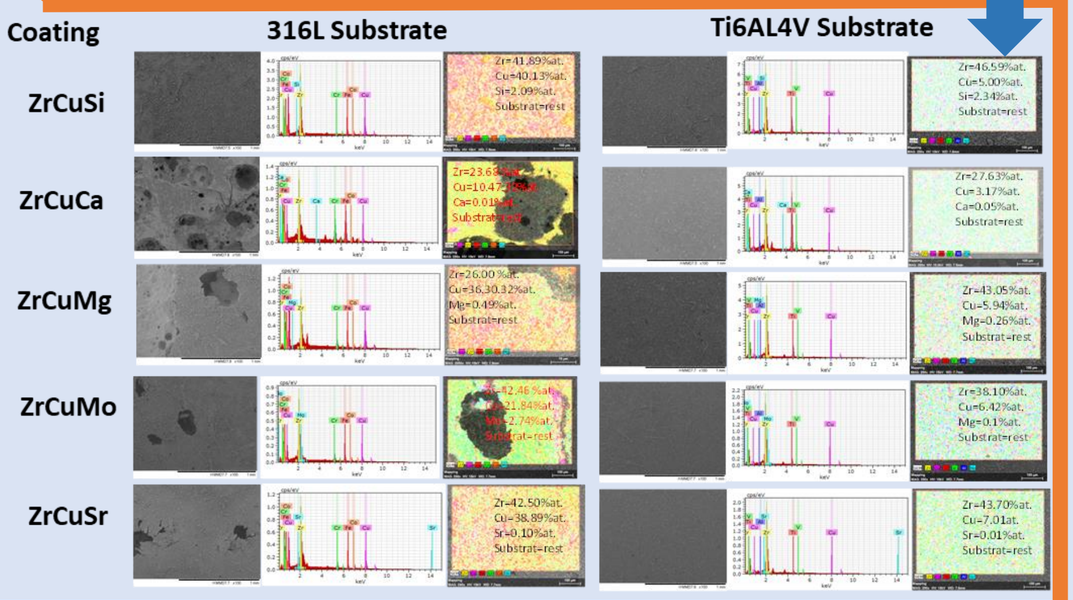
In fact, the coatings appears to be smooth, formed by many and agglomerate sharp peaks, thus indicating an uniform growth. The presence of air-pockets on surface of ZrCuSr confirms the rougher surface.





Coating	Substrate	E_{corr} (mV)	i_{corr} (nA/cm²)	R_p (Ωx cm²)
ZrCuCa	316L	-216	242.1	122.008
	Ti6Al4V	-119	284.465	204.82
ZrCuMg	316L	-235	36.35	3690.82
	Ti6Al4V	-468	18.304	2425.75
ZrCuMo	316L	-286	74.34	94.197
	Ti6Al4V	-476	90.042	492.24
ZrCuSi	316L	-326	7.685	5234.34
	Ti6Al4V	-264	31.523	2057.92
ZrCuSr	316L	-357	3.184	30459.6
	Ti6Al4V	-510	7.051	8982.28
	316L	-462	99.642	3550.22
	Ti6Al4V	-246	10.208	3175.88

The electrochemical behavior analysis of the coatings have indicated that the coatings deposited on Ti6Al4V substrate present lower values of the corrosion current density as well as a higher polarization resistance.



4. Conclusions

The Zr-based metallic glass coatings are uniform and they are covering the entire surface, regardless of the substrate.

The coatings deposited on Ti6Al4V substrate showed a better corrosion behaviour than those on 316L substrate.

The cracks can be seen on the surface both coatings, being more evident in the case of those on 316L substrate.

The presence of air-pockets on surface of ZrCuSr shows the rougher surface.

All samples present newly apatite structures formed on their surfaces and for the coatings deposited on 316L, it can be observed that there are significant signs of degradation of the coating..

5. Acknowledgement

This work was supported by grants of the Romanian Ministry of Education and Research, CNCS - UEFISCDI, project PN-III-P4-ID-PCE-2020-1264 (PCE95/2021), within PNCDI III, and Romanian National Core Program no. no. PN 23 05 (id: PN11N-03-01-2023) and contract no. 18PFE/30.12.2021.

Patent no: A100544/2022

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