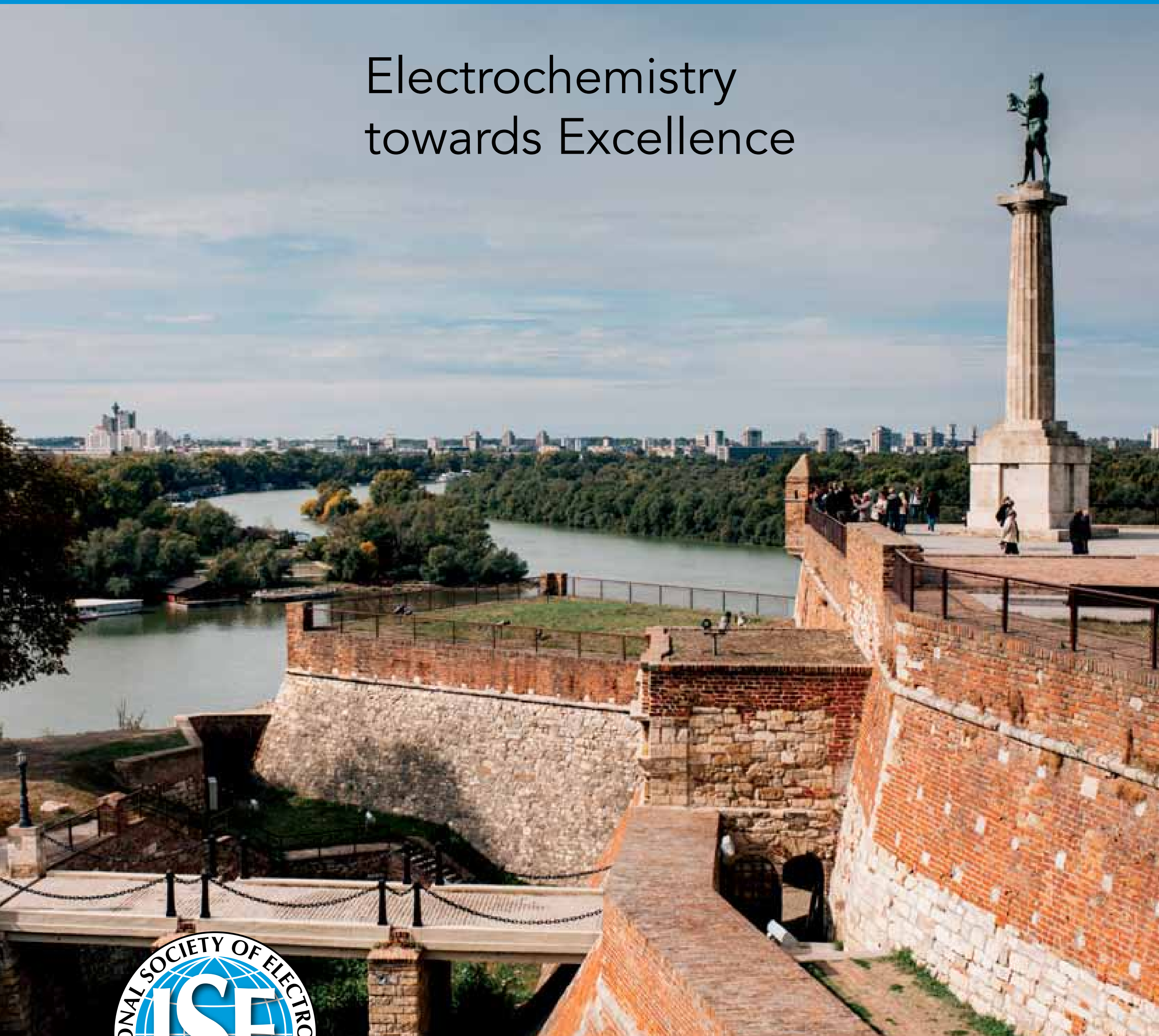
71st Annual Meeting

of the International Society of Electrochemistry

30 August - 4 September 2020
Belgrade, Serbia

Electrochemistry
towards Excellence



https://annual71.ise-online.org
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71st Annual ISE Meeting - Belgrade Online - Notification of presentation acceptance

International Society of Electrochemistry <events@ise-online.org>
Lun 06/07/2020 10:16
Para: Nestor Ruben Florido Suarez <nestor.florido@ulpgc.es>

Dear Nestor Florido Suárez,

It is our pleasure to inform you that your submission "*Correlation between the electrochemical behavior and mechanical properties of Ti-20Zr as a candidate for orthopedic material*" (ise202818) has been accepted and selected for **a Poster** presentation in symposium "s11" of the **ISE Belgrade Online Meeting**.

Please be aware that for your presentation to be maintained as **a Poster** presentation, we must receive your registration **before 31 July 2020**. To help us manage this first ISE Online Meeting, please register as soon as possible, don't wait until the last moment.

Link to registration: https://annual71.ise-online.org/registration.php

For all Oral presentations, you will soon receive more information from your Symposium Organizers.

Only registered participant will be able to submit a Poster (pdf), and will receive information about how to submit.

IMPORTANT DATES
Registration deadline for presentation(s): 31 July 2020
(Presentations without a registered speaker or Poster presenter will be cancelled and removed from the program on 01 August 2020).

With best wishes,

Jelana Bajat and Aleksandar Dekanski Organizing Committee co-chairs

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International Society of Electrochemistry
email: events@ise-online.org
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Correlation between the electrochemical behavior and mechanical properties of Ti-20Zr as a candidate for orthopedic material

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A combination of titanium with zirconium was evaluated because it has been suggested as a candidate for human body implant material and was primarily developed in response to concerns of potential cytotoxicity and adverse tissue reactions caused by vanadium and aluminum in the actually used biomaterial Ti6Al4V.

From all the metallic alloys used in prosthesis, probably the most used one is Ti-6Al-4V alloy. Titanium has poor mechanical strength [1] and when aluminium or vanadium are added to titanium in small quantities, the strength of the alloy is much increased over that of titanium [2]. Therefore, the Ti-6Al-4V alloy achieves considerably higher tensile properties than of pure titanium and this alloy is used in high stress-bearing situations. But Ti-6Al-4V has a potential cytotoxicity and adverse tissue reactions caused by vanadium [3].

Further studies have shown the release of both V and Al ions from the alloy might cause long-term health problems, such as peripheral neuropathy, osteomalacia and Alzheimer diseases.

The microstructure and microhardness were determinate; the tensile strength and electrochemical behavior were evaluated. Titanium is an allotropic element and this mean that exists in more than one crystallographic form. At room temperature has a hexagonal close-packed (hcp) crystal structure, which is referred to as 'alpha' phase. At 883ºC (1621 ºF) this structure transforms to a body-centred cubic (bcc) called 'beta' phase.

The Ti-20Zr alloy, composed of 80% Titanium and 20% Zirconium, (from R&D CS Bucharest, Romania – Research &Development Consulting and Services) was obtained by vacuum melting.

From metallographical images can be observed that the sample has an alpha-beta structure. The microhardness measurements concluded that the alloy formed a hard layer on its surface which greatly improves the wear resistance. The obtained tensile strength can be considered good in relation with other similar implant materials.

The impedance spectra were fitted with two time constants equivalent circuit and the fitting parameters indicate long-term stability of the passive layers in surgical implant conditions.

The results were confirmed by mechanical approach, in terms of two-layer model of the oxide film, consisting of a thin barrier type inner layer and a porous outer layer. The pronounced porous outer layer is expected to facilitate the incorporation of mineral ions and to improve the resistance to electrochemical corrosion over the potential of relevance for human body conditions.

The hardness of Ti-20Zr alloy is 20% higher than that of commercially pure Ti, confirming the alloy's superior mechanical strength.

REFERENCES

[1] T. Kokubo, H-M Kim, M. Kawashita, T. Nakamura, Bioactive metals: Preparation and properties, J. Mater. Sci. Mater. Med. 15(2) (2004) 99-107.
[2] T.Kokubo, F.Miyaji, H-M.Kim, Spontaneous formation of bonelike apatite layer on chemically treated titanium metals, J. Am. Ceram. Soc. 79(4) (1996) 1127-1129.
[3]S.Fujibayashi, T.Nakamura, S.Nishiguchi, J.Tamura, M.Uchida, H-M.Kim, T.Kokubo, Bioactive titanium: Effect of sodium removal on the bone-bonding ability of bioactive titanium prepared by alkali and heat treatment J. Biomed. Mater. Res. 56(4) (2001) 562-570.

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Correlation between the electrochemical behavior and mechanical properties of Ti-20Zr as a candidate for orthopedic material

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Keywords:
Biomaterials,
corrosion,
electrochemical,
orthopedic

ABSTRACT

A combination of titanium with zirconium was evaluated because it has been suggested as a candidate for human body implant material and was primarily developed in response to concerns of potential cytotoxicity and adverse tissue reactions caused by vanadium and aluminum in the actually used biomaterial Ti6Al4V.

Metallography

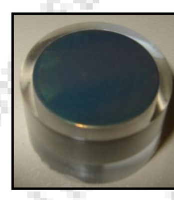
The Ti-20Zr alloy, composed of 80% Titanium and 20% Zirconium, (from R&D CS Bucharest, Romania – Research & Development Consulting and Services) was obtained by vacuum melting.

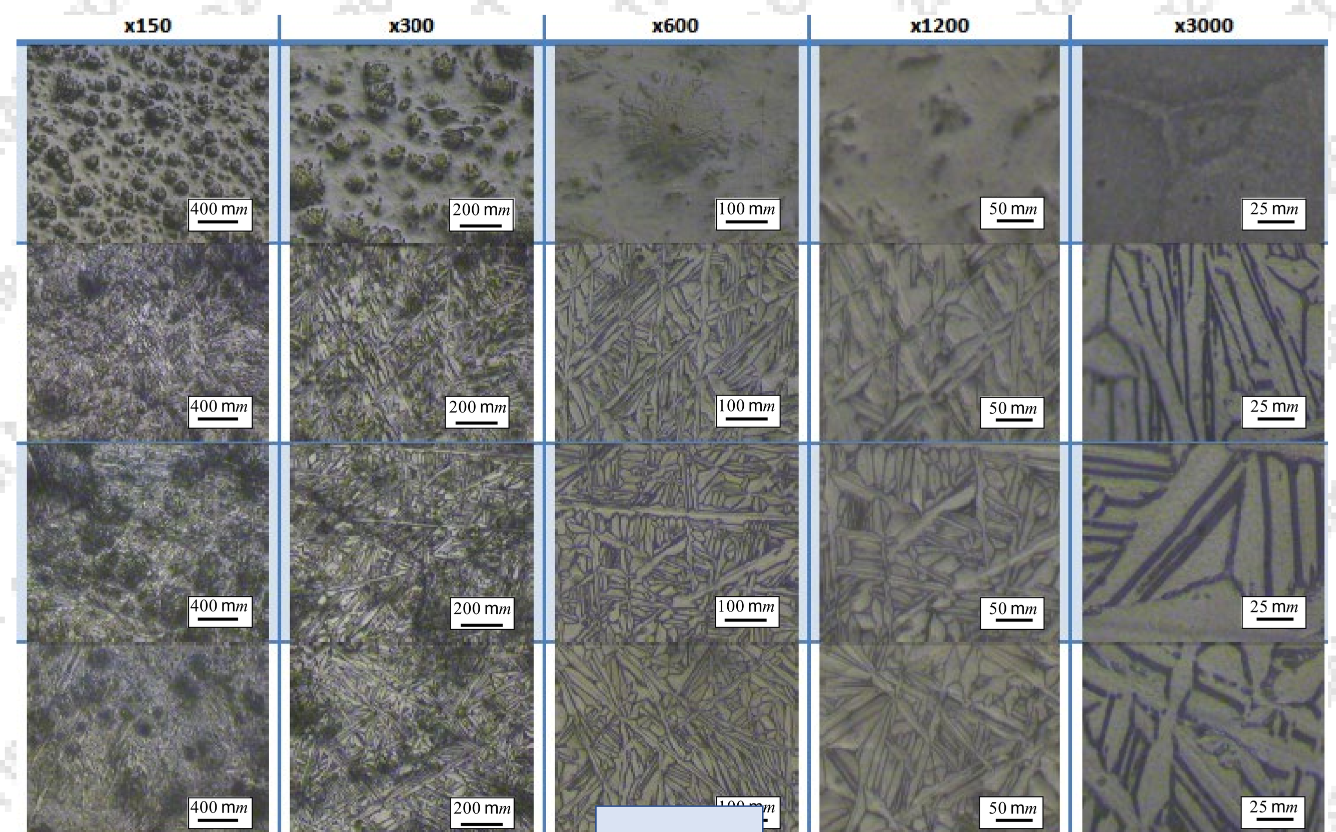
From metallographical images can be observed that the sample has an alpha-beta structure. The microhardness measurements concluded that the alloy formed a hard layer on its surface which greatly improves the wear resistance. The obtained tensile strength can be considered good in relation with other similar implant materials

Materials and Methods

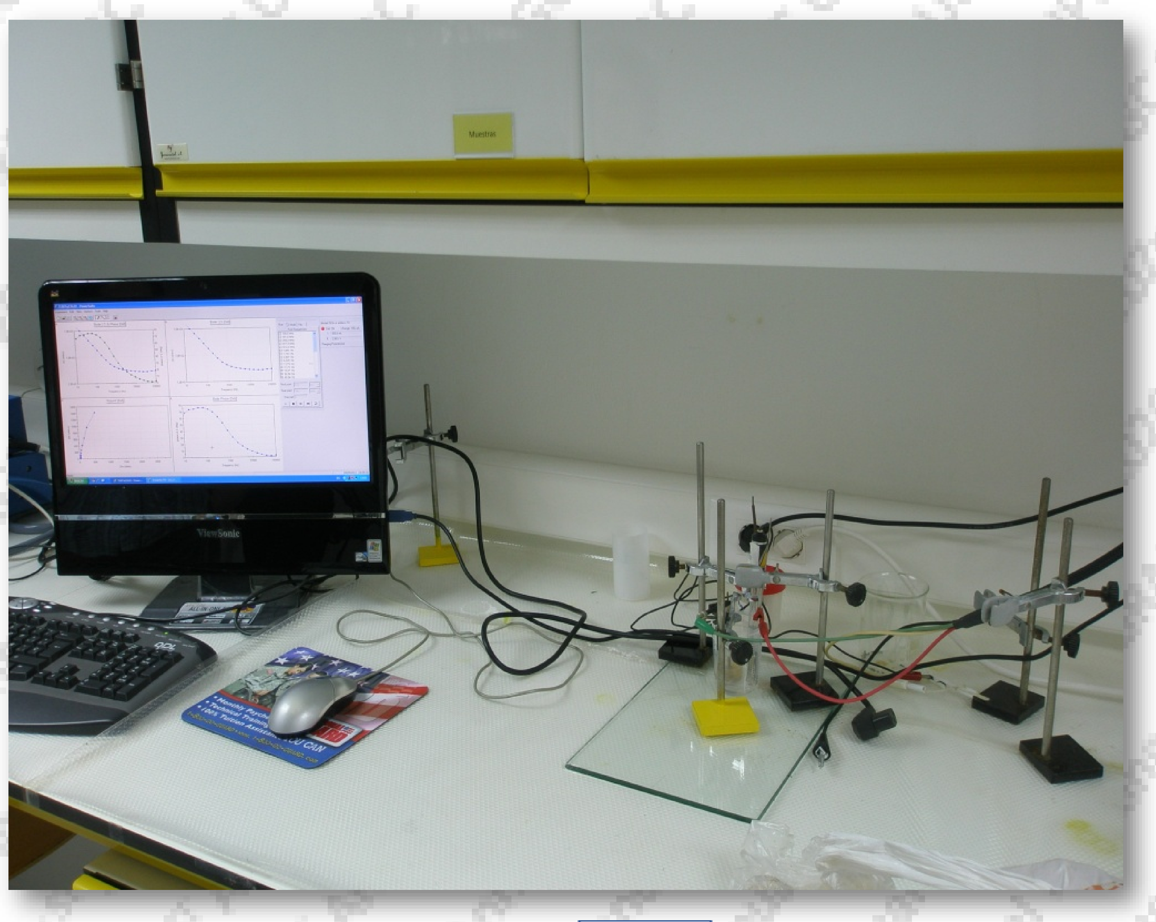
Titanio

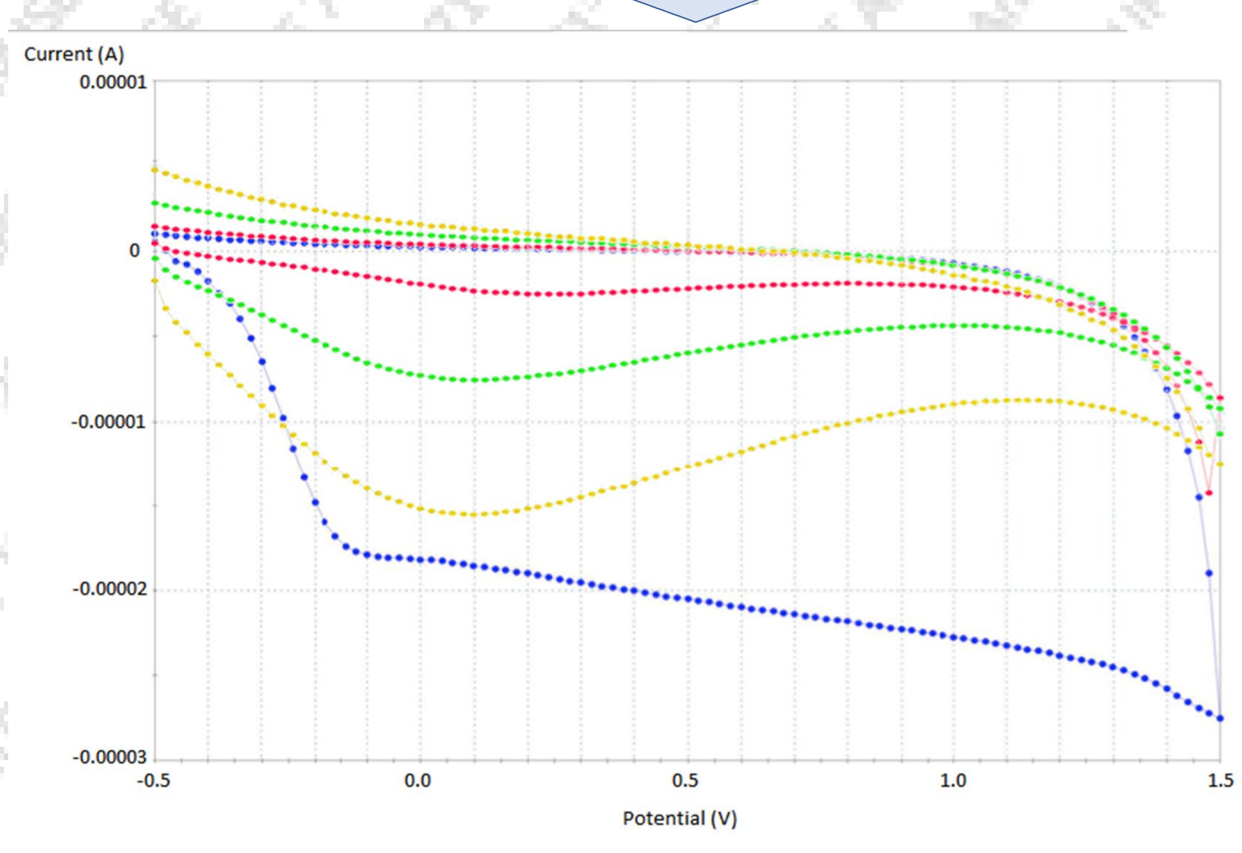
Zirconium





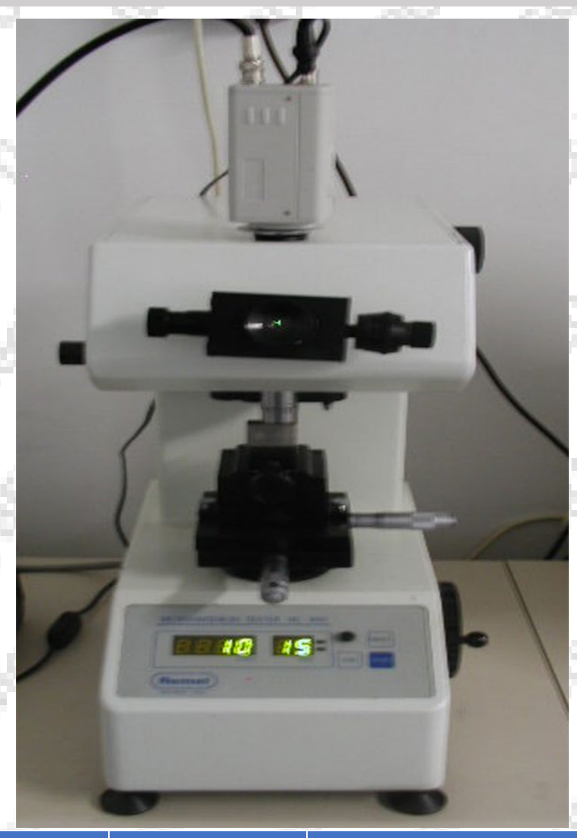
CV





The impedance spectra were fitted with two time constants equivalent circuit and the fitting parameters indicate long-term stability of the passive layers in surgical implant conditions.

Microhardness



LOAD (gf)	AVERAGE HV	BRINELL HARDNESS	TENSILE STRENGTH (psi)	TENSILE STRENGTH (MPa)
50	234	234	81917	564
100	228	228	80062	552
200	239	239	83877	578

SOFT AND HARD PHASES - Ti-20Zr

LOAD (gf)	PHASE	HARDNESS (HV)	INDENTATION DEPTH (μm)
0.5	SOFT	37.3	0.712
	HARD	50.0	0.615
1	SOFT	66.2	0.756
	HARD	91.3	0.643
2	SOFT	101.5	0.863
	HARD	145.3	0.721
3	SOFT	127.7	0.942
	HARD	197.2	0.758
4	SOFT	149.8	1.000
	HARD	214.8	0.839
5	SOFT	163.7	1.075
	HARD	288.4	0.809
10	SOFT	194.6	1.394
	HARD	242.4	1.249
20	SOFT	201.9	1.935
	HARD	298.4	1.592
50	SOFT	212.8	2.981
	HARD	255.3	2.722
100	SOFT	201.3	4.335
	HARD	256.2	3.842
200	SOFT	210.5	5.990
	HARD	268.8	5.305

CONCLUSIONS

The hardness of Ti-20Zr alloy is 20% higher than that of commercially pure Ti, confirming the alloy's superior mechanical strength.
The results were confirmed by mechanical approach, in terms of two-layer model of the oxide film, consisting of a thin barrier type inner layer and a porous outer layer. The pronounced porous outer layer is expected to facilitate the incorporation of mineral ions and to improve the resistance to electrochemical corrosion over the potential of relevance for human body conditions.