



**ELECTROCHEMICAL BEHAVIOUR OF Ni-Ti (SUPERELASTIC) ALLOY IN
ARTIFICIAL SALIVA IN THE PRESENCE OF ALMOX 500.**

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Article Received on 11/01/2018

Article Revised on 31/01/2018

Article Accepted on 21/02/2018

ABSTRACT

An investigation about the corrosion resistance of Ni-Ti (Super elastic) alloys in artificial saliva environments in presence and absence of Almox 500 has been carried out by using electrochemical techniques. Electrochemical techniques included potentiodynamic polarization curves, linear polarization resistance and AC impedance spectroscopy. Different techniques have shown that generally speaking, Ni-Ti (Super elastic) alloys show a more corrosion resistance in artificial saliva in the presence of 100 ppm almox 500 than in the presence of 50 ppm of almox 500 and in the absence of almox 500. Their corrosion resistance is increased as the quantity of almox 500 is increased in artificial saliva.

KEYWORDS: Artificial saliva, corrosion, metals, almox 500.

INTRODUCTION

As the global population increases in age, there is a parallel increase in the number of implantation procedures. The performance of any material in the human body is controlled by two sets of characteristics: biofunctionality and biocompatibility. There are wide ranges of materials available for implantation. It is relatively easy to satisfy the requirements for mechanical and physical functionality of implantable devices. When metals are considered, the susceptibility of the material to corrosion and the effect of the corrosion on the tissue are the central aspects of biocompatibility. The human body is not an environment that one would consider hospitable for an implanted metal alloy. The materials for the devices generate less concern in their biocompatibility with human body than those for implants. The basic knowledge of metal composition, microstructure and processing is necessary to select a metallic material for a specific application. Metallic materials can have serious corrosion problems in aqueous solution, such as in contact with physiological fluids. Corrosion results in releasing toxic metals ions to body and also weakening implants. Five non-precious Ni-Co based alloys have been analyzed with respect to their corrosion behaviour in artificial saliva. Many metals and alloys have been used in dentistry. Their corrosion behavior in artificial saliva has been investigated in the influence of sulfa drugs. The corrosion behavior of Ni-Ti orthodontic brackets in artificial saliva have been investigated and have studied in artificial saliva in the presence of antibiotic sulfa drugs. Corrosion behavior of metals in artificial saliva in

presence of D-glucose has been investigated. The present work is undertaken to study corrosion behavior of metal alloy in artificial saliva in the presence and absence of antibiotic sulfa drugs such as phexin and almox 500 has been investigated. Studied under potentiodynamic polarization and AC impedance spectra studies. Corrosion parameters such as corrosion potential, corrosion current, linear polarization resistance, charge transfer resistance and double layer capacitance have been derived from these studies.

MATERIALS AND METHODS

The Ni-Ti super elastic metal alloy will be used. The metal alloy specimens were encapsulated in Teflon. The surface area of the exposed metal surface was 0.0875 cm². The metal specimens were polished to mirror finish and degreased with trichloroethylene. The metal specimens were immersed in Fusayama Meyer artificial saliva, whose composition is: KCl (0.4 g/l), NaCl (0.4 g/l), CaCl₂.2H₂O (0.906 g/l), NaH₂PO₄.2H₂O (0.690 g/l), Na₂S.9H₂O (0.005 g/l), urea (1 g/l). The pH of the solution was 6.5. In electrochemical studies, the metal alloy specimens were used as working electrodes. AS was used as the electrolyte. The temperature was maintained at 37 ± 0.1°C.

Potentiodynamic polarization

Polarization studies were carried out in a CHI-Electrochemical workstation with impedance, Model 660A. A three-electrode cell assembly was used. The working electrode was Ni-Ti super elastic metal alloy. A saturated calomel electrode (SCE) was the reference

electrode and platinum was the counter electrode. From the polarization study, corrosion parameters such as corrosion potential (E_{corr}), corrosion current (I_{corr}) and Tafel slopes (anodic = β_a and cathodic = β_c) were calculated from Nyquist plots. Impedance, $\log(z/\text{ohm})$ values were calculated from bode plots.

AC impedance spectra

The instrument used for polarization study was used to record AC impedance spectra also. The cell setup was also the same. The real part (Z') and imaginary part (Z'') of the cell impedance were measured in ohms at various frequencies. Values of the charge transfer resistance (R_t) and the double layer capacitance (C_{dl}) were calculated.

RESULTS AND DISCUSSION

Potentiodynamic Polarization

Corrosion behavior of NiTi in artificial saliva in the presence of almxo 500.

METAL	System	E_{corr} mV vs SCE	β_c mV/decade	β_a mV/decade	LPR	I_{corr} A/cm ²
NiTi (SUPER ELASTIC)	Control (AS+METAL)	85	250	200	5.40×10^7	6.435×10^{-11}
	AS + METAL + Almxo 500 -0.05g	277	300	280	6.55×10^7	2.398×10^{-11}
	AS + METAL + Almxo 500 - 0.1g	362	125	400	8.99×10^7	5.337×10^{-11}

Ni - Ti Alloy with Artificial saliva

The Ni - Ti Alloy is immersed in artificial saliva the corrosion potential is 85 mV and the corrosion current is $6.43 \times 10^{-11} \text{A/cm}^2$. In Tafel slopes cathodic value is 250 mV and anodic value is 200 mV.

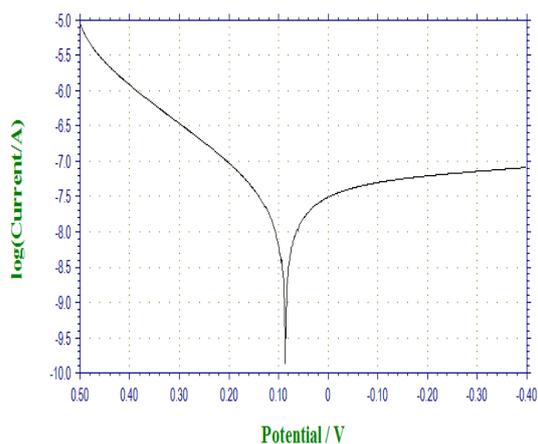
Ni - Ti Alloy + AS + Almxo 500 - 0.05g

In this Ni - Ti is immersed in artificial saliva with 0.05 g of Almxo 500 the corrosion potential shifted to the cathodic side. The cathodic Tafel value is higher than the anodic value this indicates that the change of current with the change of potential was high in the cathodic region than in the anodic region. This is due to the formation of a protective film on the anodic sites of the

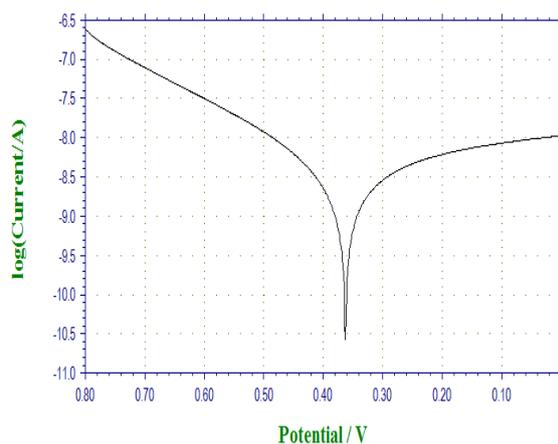
metal surface. This prevents the corrosion of metal. It was interesting to note that in the presence of almxo 500 (0.05g).

Ni - Ti Alloy + AS + Almxo 500 - 0.1g

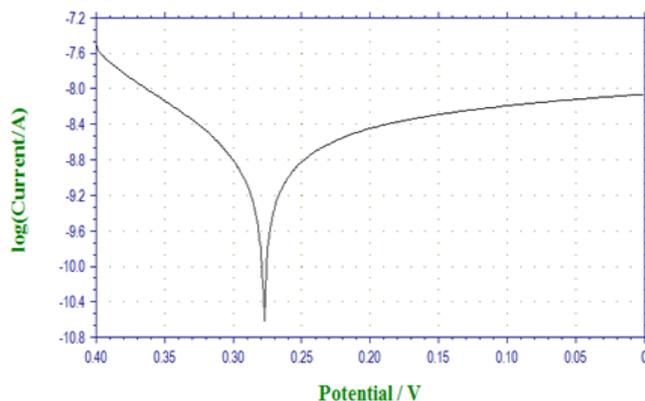
In this Ni - Ti Alloy is immersed in artificial saliva with 0.1g of Almxo 500 the corrosion potential is 362 and the cathodic Tafel value is 125 and anodic Tafel value is 400. This indicates that this is more corrosion resistant than NiTi in AS contained almxo 500 - 0.05g. A protective layer was formed on the metal surface. Suggested that during anodic polarization, the rate of change of corrosion current with potential was high and it was less during the cathodic polarization.



Control (NiTi + AS)



NiTi + AS + 0.1g Almxo 500



NiTi + AS + 0.05g Almox500

AC impedance

AC impedance parameters such as charge transfer resistance (R_t), double layer capacitance (C_{dl}) (derived

from Nyquist plots) and impedance value $\log(z/\text{ohm})$ (derived from Bode plots), of NiTi alloy immersed in artificial saliva with almox 500.

METAL	SYSTEM	NYQUIST PLOT		BODE PLOT IMPEDANCE $\log(Z/\text{Ohm})$
		R_t ohm cm^2	C_{dl} $\mu\text{F}/\text{cm}^2$	
NiTi (SUPER ELASTIC)	Control (AS+ALLOY)	3122	6.279×10^{-10}	5.2
	AS + ALLOY+ Almox 500 -0.05g	11287	3.961×10^{-10}	5.2
	AS + ALLOY+Almox 500 – 0.1g	238651	2.137×10^{-11}	5.3

Ni - Ti Alloy + AS

The Ni – Ti Alloy immersed in artificial saliva shows the charge transfer resistance value is 3122.6 ohm cm^2 . The double layer capacitance value is $6.279 \times 10^{-10} \mu\text{F}/\text{cm}^2$. The impedance value is 5.4.

shows that there is protective film formed on the metal surface.

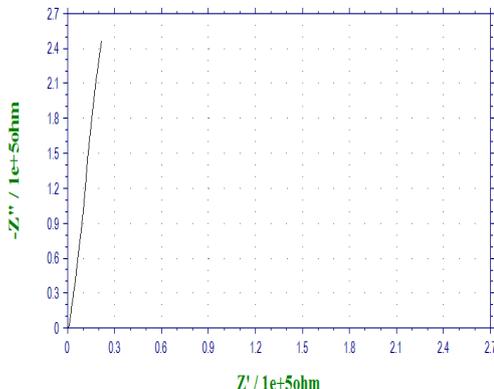
Ni - Ti Alloy + AS + Almox 500 – 0.05g

In the presence of 0.05g of almox 500 the R_t value increases from 3122 to 11287. The C_{dl} value is decreases from 6.279×10^{-10} to 3.961×10^{-10} . This is

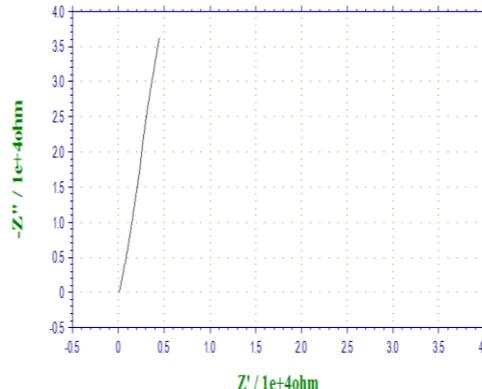
Ni – Ti Alloy + AS + Almox 500 – 0.1g

In the presence of 0.1g of almox 500 the R_t value is increases from 3122 to 238651. The C_{dl} value decreases from 6.279×10^{-10} to 2.137×10^{-11} . The impedance value increases to 5.3. According to this values shows that the 0.1g of almox 500 having more corrosion resistance than 0.05g of almox 500.

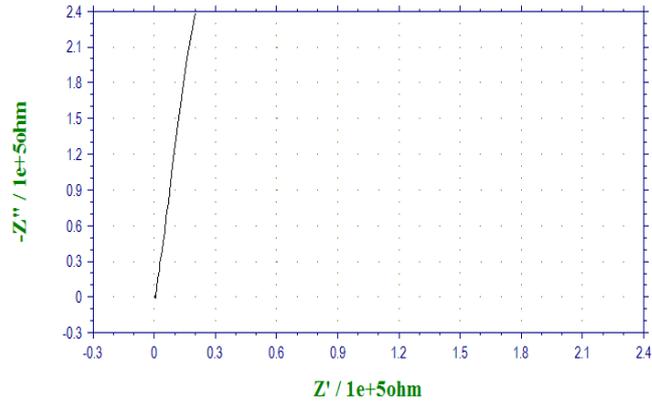
Nyquist plots



Control (Ni -Ti)

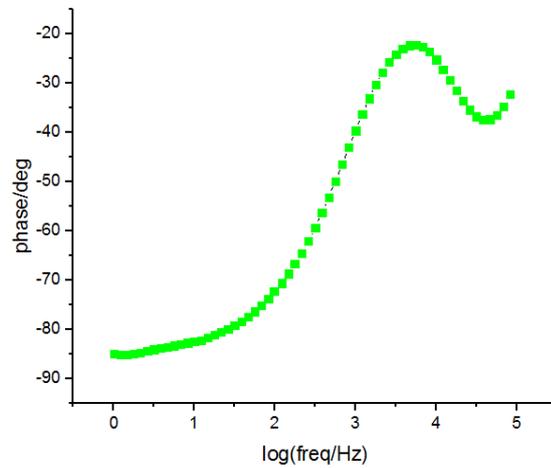
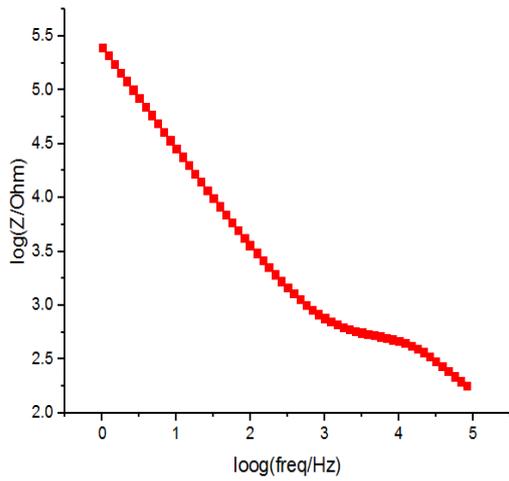


Ni – Ti AS + Almox 500 – 0.05g

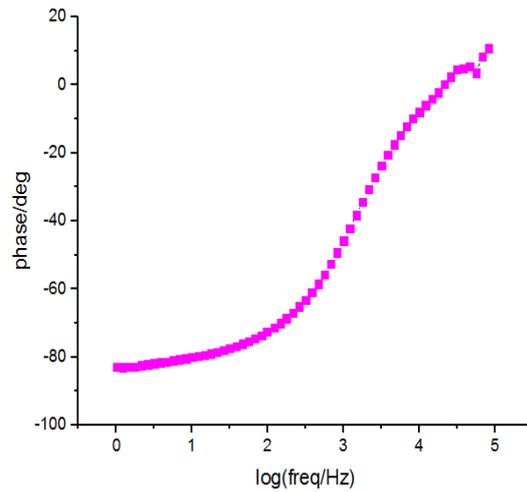
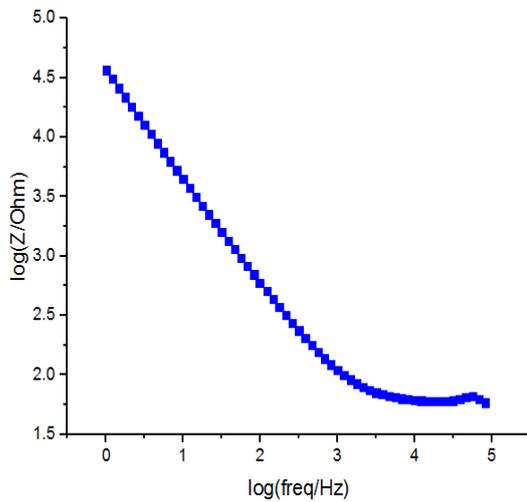


NiTi+ AS + Almox 500 – 0.1g

Bode plots



Control



Ni - Ti + AS + Almox 500 – 0.05g

