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# Electrochemical study of 18 carat gold with artificial saliva in presence of aceclofenac 100 Mg tablet.

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## Abstract

The electrochemical behavior of 18 carat gold in the presence of artificial saliva with and without Aceclofenac100 mg Tablet has been evaluated by AC impedance spectra and Polarization studies. Usually orthodontic wires made of many metals and alloys. After treatment of many food items such as glucose, rasam, sambar,buttermilk etc are taken orally. Many tablets are also orally taken. Aceclofenac100 mg is non-steroidal and anti-inflammatory drug. It is used to treat pain, and inflammation. In the oral environment these orthodontic wires undergo many types of corrosion. In the present study the corrosion behavior of 18 carat gold orthodontic wire in presence of artificial Saliva with a tablet namely, Aceclofenac100 mg orally taken has been investigated by AC impedance spectra and polarization study. Nyquist plots and Bode plots have been drawn. Charge transfer resistance ($R_t$), double layer capacitance ($C_{dl}$) and Impedance values have been calculated. It is observed from electrochemical studies, the corrosion resistance of 18 carat gold electrode increases in presence of artificial saliva with Aceclofenac100 mg. So, people having orthodontic wire made of 18 carat gold need not hesitate to take Aceclofenac100 mg tablet.

**Keywords:** Aceclofenac100 mg, AC impedance spectra, Orthodontic wires, dentistry, 18 carat gold, polarization study.

## Introduction

Nowadays dentistry, metallic materials are used as implants in reconstructive oral surgery to replace a single tooth or an array of teeth or in the construction of dental prostheses such as metal plates for complete and partial dentures crowns, and bridges. Corrosion of metallic

implants is of vital importance, because it can adversely affect the bio-compatibility and mechanical integrity of implants. Many metals and alloys have been used in dentistry. The corrosion behavior of artificial saliva has been investigated. The corrosion resistance of the commercial metallic orthodontic wires in a simulated intra-oral environment has been evaluated by Ziebowicz*et.al.* [1].The effect of different concentrations of eugenol in artificial saliva on titanium corrosion has been investigated by Kinani and Chtaini [2]. Five non-precious Ni-Co based alloys have been analyzed with respect to their corrosion behavior in artificial saliva [3].Rajendran et al., have been evaluated the corrosion resistance of various electrodes such as stainless steel 316L, mild steel (MS), and mild steel coated with zinc (MS-Zn) has been evaluated in artificial saliva in the absence and presence of spirulina, and electrol [4-5]. The corrosion resistance of 18 ct gold in artificial saliva in the presence of Almox 250 DT has been investigated by Krishnaveni [6]. Saranya et al., have been investigated the corrosion resistance of 18 ct gold in artificial saliva in the absence and presence of D-Glucose [7]. Madhumitha et al., have been investigated the corrosion resistance of 22 ct gold and Thermo active Super elastic shape memory alloy in presence of Syzygium cumin Fruit juice [8]. Aceclofenac100 mg is non-steroidal anti-inflammatory drug. Which is used to treat pain and inflammation. Many researchers have been reported that the18ct gold with different tablets in presence of artificial saliva. The present study leads to investigate the corrosion behavior of orthodontic wire made of 18 carat gold in artificial saliva with a tablet namely, Aceclofenac100 mg orally taken**.** Electrochemical spectra such as polarization studies and AC impedance spectra have been used. The composition of Aceclofenac100 mg is given Scheme1.

Scheme 1: The composition of Aceclofenac100 mg

| | |
|---|---|
| AceclofenacIP | 100mg |

**Materials and Methods:**

The composition of 18 carat gold is 75% of gold, 5-15% of Cu and 10-20% of Ag. The orthodontic wire was encapsulated in Teflon. The wire was polished to a mirror finish and degreased with trichloroethylene. The electrochemical studies were carried out in a three electrode cell assembly. The three electrodes were immersed in Fusayama Meyer artificial saliva (AS), whose composition is given in Table 1.

**Table1: Composition of Artificial saliva**

| Name of salt | Weight (g/lit) |
|---|---|
| KCl | 0.4 |
| NaCl | 0.4 |
| $CaCl_2.2H_2O$ | 0.906 |
| $NaH_2PO_4.2H_2O$ | 0.690 |
| $Na_2S.9H_2O$ | 0.005 |
| urea | 1 |

The pH of the solution was 6.5. In electrochemical studies, the metal specimens were used as working electrodes. Artificial saliva (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 (Fig 1). The working electrode was 18 ct gold. 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 = $b_a$ and cathodic = $b_c$) were calculated.

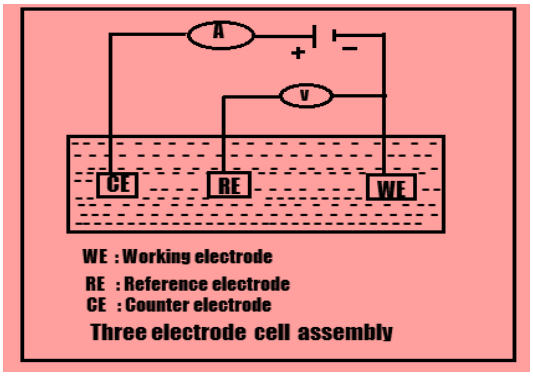


**Fig 1: Three electrode cell assembly**

**AC Impedance Spectra**

The instrument used for polarization study was also used to record AC impedance spectra. The cell setup was also the same of Potentiodynamic polarization. The real part (Z') and imaginary part (Z") of the cell impedance were measured in ohms at various frequencies. The values of the charge transfer resistance ($R_t$) and the double layer capacitance ($C_{dl}$) were calculated from Nyquist plot. Impedance: log (z/ohm) value was calculated from Bode plots.

**Analysis of potentiodynamic polarization studies**

Electrochemical polarization studies have been used to confirm the formation of protective film formed on the metal surface during corrosion inhibition process [9-15]. If a protective film is formed on the metal surface, the corrosion current value ($I_{corr}$) decreases and corrosion potential value ($E_{corr}$) increases. The potentiodynamic polarization curves of 18 ct gold immersed in Artificial Saliva (AS) in the absence and presence of Aceclofenac 100 mg, obtained from polarization study are shown in Fig-2. The corrosion parameters, namely, corrosion potential ($E_{corr}$ mV vs SCE), Tafel slopes **(**$b_c$ mV/decade; $b_a$ mV/decade), linear polarization resistance (LPR ohm $cm^2$), and corrosion current ($I_{corr}$ A/$cm^2$) values are given in Table 2.0

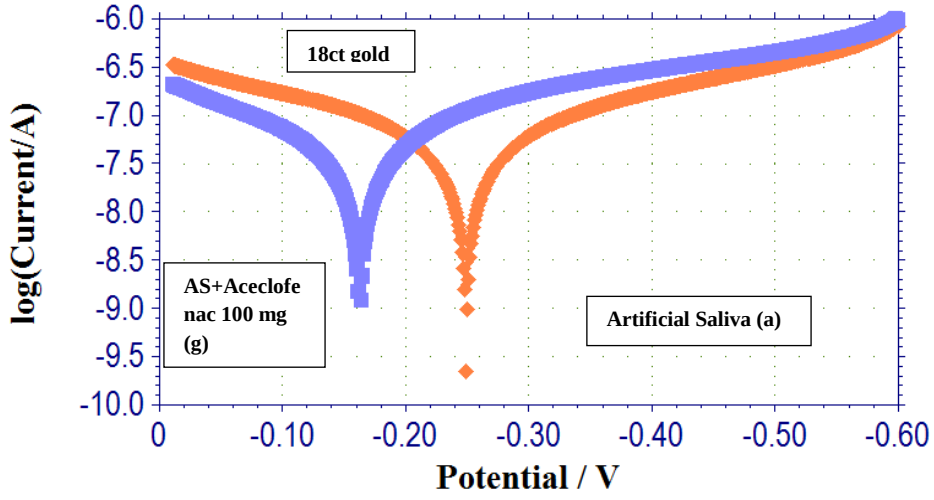


**Fig 2: Polarization curves of 18 ct gold immersed in Artificial Saliva (AS) in the absence and presence of Aceclofenac 100 mg**

**(a) Artificial Saliva (AS); (g) AS + Aceclofenac 100 mg (200 ppm)**

When 18 ct gold is immersed in Artificial Saliva (AS), the corrosion potential is -249 mV vs SCE. When Aceclofenac 100 mg (200 ppm) is added to the above system the corrosion potential is shifted to the anodic side (-163 mV vs SCE). This indicates that the anodic reaction is controlled predominantly. The LPR value increases from 839887.2 ohm $cm^2$ to 883431.2 ohm $cm^2$, the corrosion current decreases from $5.490x10^{-8}$A/$cm^2$ to $5.202x10^{-8}$A/$cm^2$. All these observations lead to the conclusion that in presence of Aceclofenac 100 mg (200 ppm) the corrosion resistance of 18 ct gold increases. Hence the polarization study leads to the conclusion that people having orthodontic wires made of 18 ct

gold need not hesitate to take Aceclofenac 100 mg tablets. The active ingredients of the tablets have not corroded the orthodontic wires made of 18 ct gold.

**Table 2: Corrosion parameters of 18 ct gold immersed in Artificial Saliva (AS) in the absence and presence of Aceclofenac 100 mg, obtained from polarization study**

| System | $E_{corr}$(mV vs SCE) | $b_c$ (mV/ decade) | $b_a$ (mV/ decade) | LPR (ohm $cm^2$) | $I_{corr}$ ($A/cm^2$) |
|---|---|---|---|---|---|
| AS | -249 | 208 | 217 | 839887.2 | $5.490 \times 10^{-8}$ |
| AS + Aceclofenac 100 mg (200 ppm) | -163 | 203 | 198 | 883431.2 | $5.202 \times 10^{-8}$ |

**Analysis of AC Impedance spectra**

AC impedance spectra (electro chemical impedance spectra) have been used to confirm the formation of protective film on the metal surface. If a protective film is formed on the 18 ct gold surface, charge transfer resistance ($R_t$) increases; double layer capacitance value ($C_{dl}$) decreases and Impedance value increases. The AC impedance spectra of 18 ct gold immersed in Artificial Saliva (AS) in the absence and presence of Aceclofenac 100 mg, obtained from AC impedance spectra are shown in Figs.3.0 to 3.2.The AC impedance parameters namely charge transfer resistance ($R_t$) and double layer capacitance ($C_{dl}$) derived from Nyquist plots (Fig 3.0) are given in Table 3. The impedance value derived from Bode plots (Figs 3.1and 3.2) are also given in this Table 3. It is observed that when Aceclofenac 100 mg (200 ppm) is added to artificial saliva, the charge transfer resistance ($R_t$) increases from 1875 $\Omega$ $cm^2$ to 1911 $\Omega$ $cm^2$. The $C_{dl}$ value decreases from $2.84 \times 10^{-8}$ $F/cm^2$ to $2.66 \times 10^{-8}$ $F/cm^2$.The impedance value increases from 3.657 to 3.718. These results lead to the conclusion that there is protective film formed on the metal surface.

All these observations reveal that in presence of Aceclofenac 100 mg (200 ppm) the corrosion resistance of 18 ct gold in contact with artificial saliva increases. Hence AC

impedance spectra lead to the conclusion that people having orthodontic wires made of 18 ct gold need not hesitate to take Aceclofenac 100 mg tablets. The active ingredients of the tablets have not corroded the orthodontic wires made of 18 ct gold; they have protected the wire by formation of protective film on the surface of the wires.

**Table 3: AC impedance parameters of 18 ct gold immersed in Artificial Saliva (AS) in the absence and presence of Aceclofenac 100 mg, obtained by AC impedance spectra.**

| System | $R_t$ (ohm $cm^2$) | $C_{dl}$ (F/ $cm^2$) | Impedance Log(z/ohm) |
|---|---|---|---|
| AS | 1875 | $2.84x10^{-8}$ | 3.657 |
| AS + Aceclofenac 100 mg (200 ppm) | 1911 | $2.66x10^{-8}$ | 3.718 |

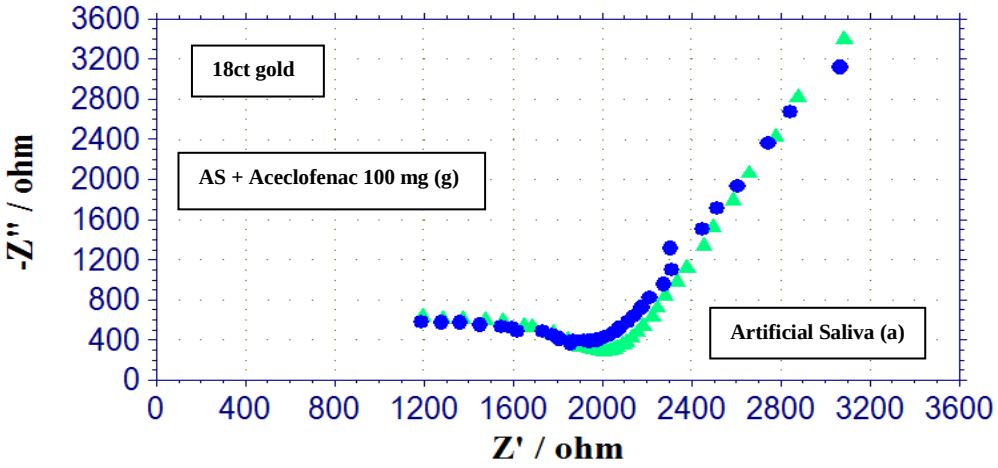


**Fig3.0**: **AC impedance spectra (Nyquist Plots) of 18 ct gold immersed in Artificial Saliva (AS) in the absence and presence of Aceclofenac 100 mg**

**(a) Artificial Saliva (AS) ; (g) AS + Aceclofenac 100 mg (200 ppm)**

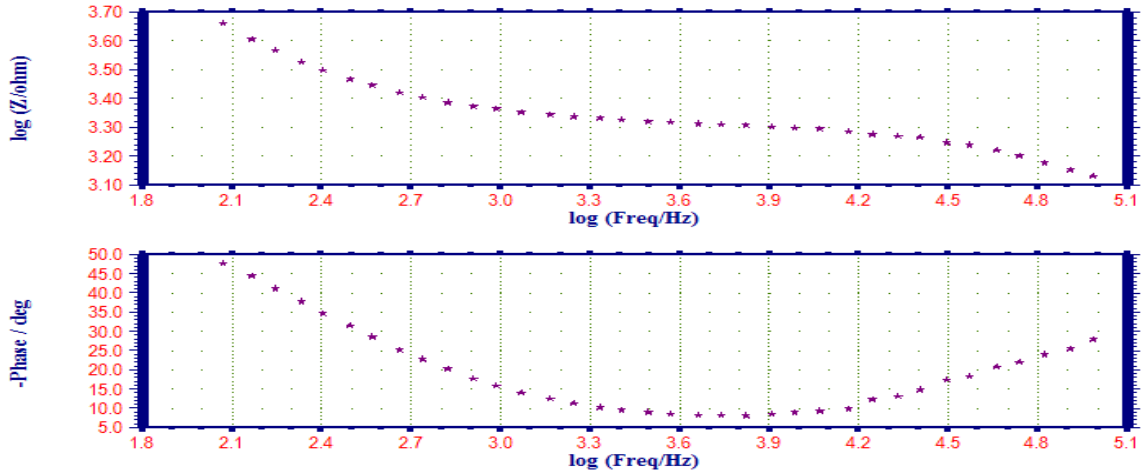


**Fig 3.1: AC impedance spectra (Bode Plots) of 18 ct gold immersed in Artificial Saliva (AS) in the absence of Aceclofenac 100 mg**

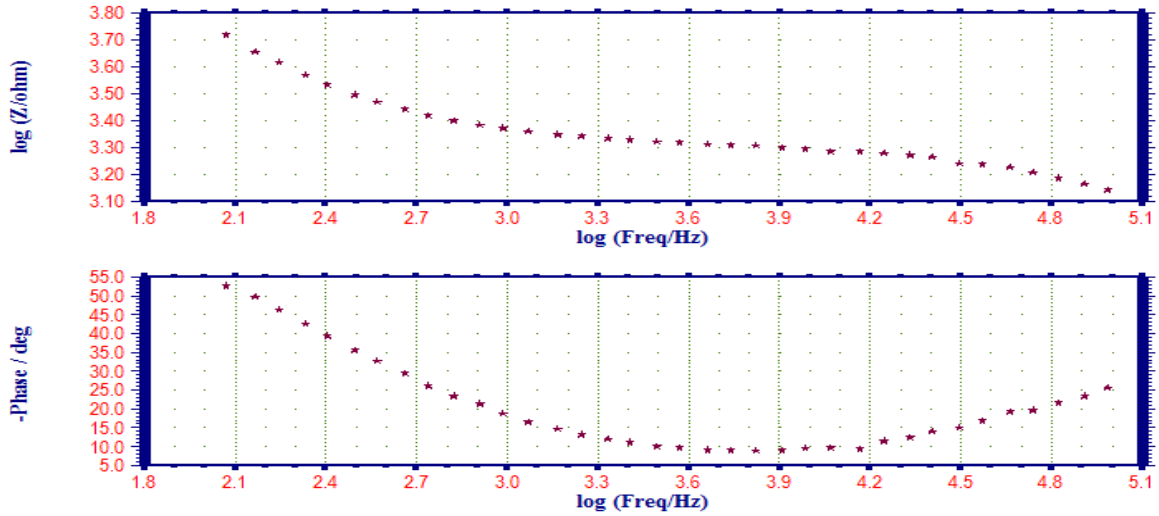


**Fig 3.2: AC impedance spectra (Bode Plots) of 18 ct gold immersed in Artificial Saliva (AS) in the absence of Aceclofenac 100 mg**

**Conclusion:**

Results of the electrochemical studies lead to the conclusion that in presence of **Aceclofenac 100 mg** (200 ppm) the corrosion resistance of 18 ct gold in contact with artificial saliva increases.

**Implication:**

The outcome of the study is that people having orthodontic wires made of 18 ct gold need not hesitate to take **Aceclofenac 100 mg** tablets. The active ingredients of the tablets have not corroded the orthodontic wires made of 18 ct gold; Indeed They have protected the wire by formation of protective film on the surface of the wires.

## ACKNOWLEDGEMENT

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