

Corrosion Resistance of AVINENT Dental Implants

PURPOSE

To determine the effect of the AVINENT surface on corrosion resistance.

MATERIALS AND METHODS

These electrochemical tests were performed on dental implants 12 mm long and 4 mm in diameter having a surface area of 191.1 mm².

The tests performed for determining electrochemical properties were:

- **Open Circuit Potential**
- **Cyclic Potential**

Both tests were performed by using a 200 ml capacity glass electrolytic cell connected to a VOLTALAB PGZ 301 potentiostat connected to a computer from which the entire test was controlled through the use of VOLTMASTER4 software. In this study an Ag/AgCl electrode was utilized as a reference electrode and a platinum electrode was utilized as an auxiliary or counter-electrode (fig. 1).

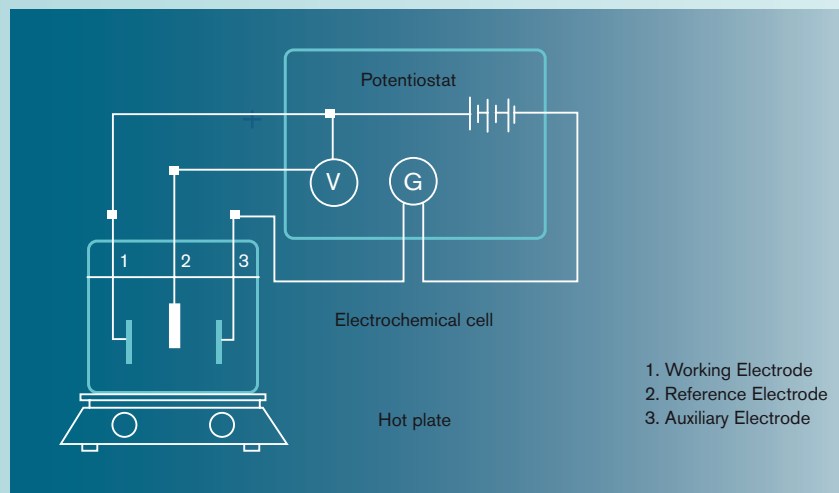


Figure 1. Setup for performing tests.

Document prepared by the **scientific committee of AVINENT Implant System S.L.** ⁽¹⁾ with the collaboration of **CREB** (Centre de Recerca en Enginyeria Biomèdica) ⁽²⁾ and the **CTM** (Centre Tecnològic) ⁽³⁾. Both these centers belong to the **UPC** (Universitat Politècnica de Catalunya).

⁽¹⁾ **Scientific committee of AVINENT Implant System S.L.**, A. Cortina, C. Vendrell, E. Falcó, J. Serra

⁽²⁾ **CREB**: A. Mestre

⁽³⁾ **CTM**: J. Caro, Ma D. Riera, J. M. Prado

Open circuit potential and cyclic voltammetry tests were performed at a temperature of 37.5° C by utilizing Hank's balanced salt solution (Sigma) with a pH = 7.13 as an electrolyte. This electrolyte was selected because it is a commercial solution with ionic contents similar to those in human plasma, and it is the solution recommended by international standards for tests of this kind. The chemical composition of this solution is detailed on table 1. All voltage readings were referenced to the standard Ag/AgCl electrode. In open circuit potential tests, the specimen was left to stabilize submerged in this electrolyte for 40 minutes and the difference in potential between the specimen and the reference electrode was recorded. In the case of the cyclic potential tests, a voltage ramp with a 1 mV/s ramp rate was used in the optimum direction between the specimen and the reference electrode, and the value of the current circulating between the specimen and the auxiliary electrode was recorded.

In the event that the titanium oxide layer produced during surface treatment were to become partially damaged, there would be a potential for formation of a galvanic couple between treated and untreated areas. For this reason, cyclic potential and open circuit potential curves were also determined for a partially treated implant, where a 7 mm² area close to the apex was left untreated.

COMPOUND	CONCENTRATION (G/L)
CaCl ₂ .H ₂ O	0.18
KCl	0.4
KH ₂ PO ₄	0.06
MgO ₂ .6H ₂ O	0.08
MgSO ₂ .7H ₂ O	0.7
NaCl	8
NaHCO ₃	0.35
Na ₂ HPO ₄	0.48
D-glucosa	1

Table 1. Chemical composition, *Hank's balanced salt solution*.

Corrosion Resistance of AVINENT Dental Implants

RESULTS

a. Open Circuit Potential

The open circuit potential test showed that the AVINENT implants had a more positive stabilization potential (282 mV Vs Ag/AgCl) than the implant without surface treatment (-21 mV Vs Ag/AgCl). This means that the AVINENT surface improves the material and therefore increases corrosion resistance in the medium selected (fig. 2).

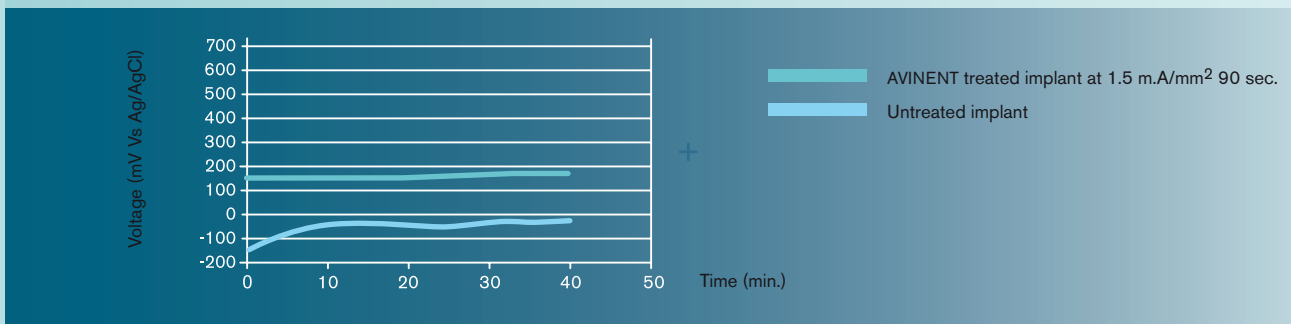


Figure 2. Open circuit potential curves for treated and untreated implants.

b. Cyclic Potential

The cyclic potential curves repeated the results obtained with the open circuit potential curves. The AVINENT implants showed high corrosion resistance, with current densities much lower than in untreated implants. The AVINENT implant showed high repassivation capability as shown by the current drop until reaching zero values when the polarization cycle was reversed; that is, in a route of progression toward lesser potentials. Oxidation peaks found with the untreated implant are associated with structural changes in the oxides present on the surface (fig. 3).

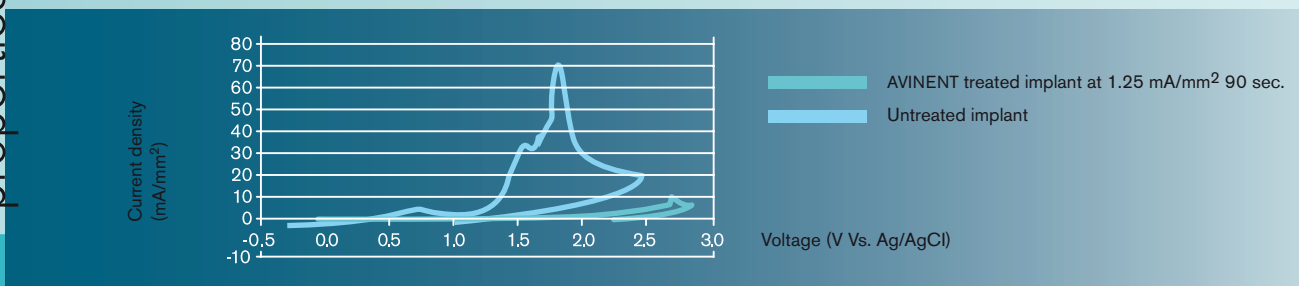


Figure 3. Cyclic potential curves, treated and untreated implants.

c. Corrosion Resistance of a Partially Treated Implant

The partially treated implant showed less corrosion resistance than the fully treated implant, but it remained higher than for the untreated implant. Open circuit potential became stabilized at around 70 mV (fig. 4) and the cyclic potential curves repeated the alloy's repassivation capability (fig. 5).

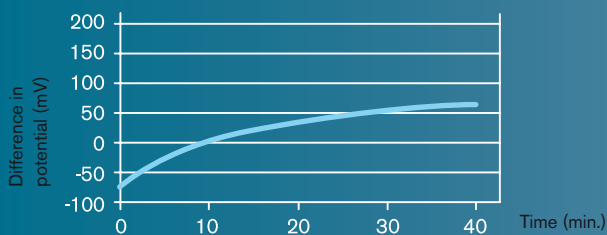


Figure 4. Open circuit potential curves for a partially treated implant.

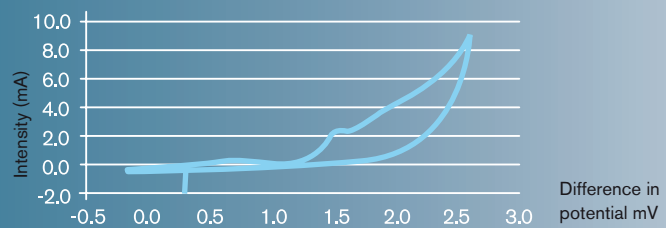


Figure 5. Cyclic potential curve for a partially treated implant.

CONCLUSIONS

Tests performed to evaluate the corrosion resistance of the AVINENT implant showed that this surface considerably improved the untreated implant's good corrosion resistance by stabilizing the surface oxide layer. It was also shown that the effect of the formation of a galvanic couple between the treated area and potentially untreated areas does not suppose any significant decrease in corrosion resistance, and will therefore have no effect at all on the implant's good behavior in service.

On the other hand, it is observed that the pitting or corrosion potential of treated implants is around 1300 mV Vs Ag/AgCl, which is much higher than the potentials that can be usually found in the mouth (around 200 mV Vs ESC) [1], thus ensuring the implant's corrosion resistance in service.

REFERENCES

- [1] Ewers G. J, Greener E. H. *The electrochemical activity of the oral cavity. A new approach.* J. of oral rehab. 12 (1985).