

# Bioactivity and Corrosion Resistance of Novel Coatings Containing Strontium by Anodic Oxidation

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## 1. Abstract

The micro-arc oxidation (MAO) technique is an effective method to improve surface properties. This study aimed to investigate bioactivity and corrosion resistance of the coatings containing different contents of strontium by MAO. After immersion in simulated body fluid, the MAO coating were covered with apatite which indicated that MAO coating will be biocompatible. The electrochemical test results revealed that MAO coating layer provided the corrosion resistance. Consequently, this study indicates that the MAO coatings could improve bioactivity and corrosion resistance.

## 2. Introduction

Titanium and its alloys are widely used in dental and orthopedic fields because of their excellent mechanical properties and chemical stability. The MAO process is an effective technique to form oxide coating to improve the metal surface properties. Strontium inhibits bone resorption and improves bone formation [1]. In previous study, we investigated the characteristics and biological response of MAO coatings containing different of strontium. Therefore, the aim of this study was evaluated the bioactivity and corrosion resistance of MAO coatings containing strontium.

## 3. Materials and Methods

Plates of medical grade titanium (CP-Ti, Grade 2, ASTM F-67, S-Tech, Tainan, Taiwan) were selected as substrate. The MAO coatings were constructed in a two-electrode electrochemical cell with applied voltage at 350 V for 1 min. The specimens were soaked in simulated body fluid (SBF) with a surface area to solution volume ratio of 0.1 cm<sup>-1</sup>. After the immersion, the specimens surface morphology were observed by scanning electron microscopy (SEM) with energy dispersive X-ray spectrometer (EDX) for chemical analysis. The solutions were evaluated by measuring the ions left by inductively coupled plasma (ICP) emission spectroscopy. A potentiostat (Autolab Pgstat 30) was used for potentiodynamic polarization test in SBF (pH 7.4) at 37°C. After the specimens were immersed for 1 hr, the beginning potential set at 700 mV active to rest potential at scan rate of 5 mVmin<sup>-1</sup> up to a potential 5000 mV. The corrosion current density ( $I_{corr}$ ), corrosion potential ( $E_{corr}$ ), and polarization resistance ( $R_p$ ) were calculated by Tafel extrapolation (ASTM G3-89).

## 4. Result and Discussion

The surface morphologies of MAO coatings soaked for 7 days are shown in Fig. 1. After 7 days of immersion, the apatite were completely covered. This implies that MAO coatings show apatite forming ability. The Sr-HA coating by plasma-sprayed was completely covered with apatite

layer after 3 days of immersion in SBF [2]. After the immersion, the ion concentration of various elements in the SBF were determined by ICP. The Ca and P ion concentration decreased after immersion in SBF for 1-7 day. Moreover, Sr ion concentration increased with increasing time. The atomic percent of the Ca and P elements, determined by EDX analysis, were contrary to ICP analysis. It is suggested that the ions concentration by ICP were corresponded with EDX analysis.

The results of the cyclic potentiodynamic polarization curves for the MAO coatings containing strontium are shown in Fig. 2. In the passive region, the MAO coatings, which reduced corrosion current to a low level, played an important role in corrosion resistance against an aggressive environment.

## 5. Conclusions

The MAO technique can introduce various designed elements into coating. In bioactivity, the SEM, ICP, and EDX results of the findings proved precipitation of apatite on the surface of the MAO coatings. In electrochemical corrosion behavior, the potentiodynamic polarization curves suggest that the MAO coatings improve the corrosion resistance of titanium.

## References

- [1] Capuccini C et al. Acta Biomater. 2008;4:1885-1893.
- [2] Xue WC et al. Surf Coat Technol. 2007; 201:4685-4693.

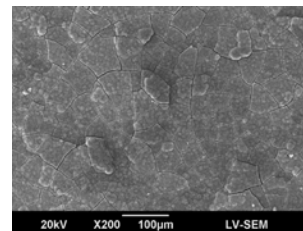


Fig. 1 The surface morphologies of MAO coatings containing strontium 1% soaked for 7 days.

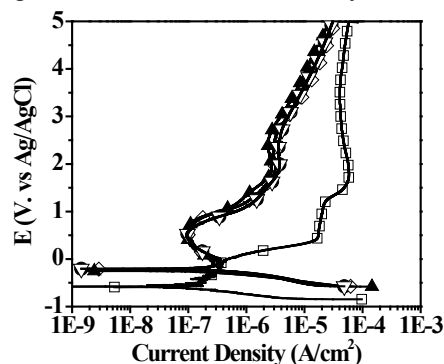


Fig. 2 The cyclic potentiodynamic polarization curve of sample in SBF solution. □: Ti; ●: Sr 0%; ◇: Sr 1%; ▲: Sr 5%; ▽: Sr 10%.