

# Calcium phosphate film formation on TiN surface created by atmospheric-pressure plasma

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We research improvement of biocompatibility of Ti alloy using atmospheric-pressure plasma nitriding. Four types of samples were immersed in simulated body fluid and the calcium phosphate formation on the surface was compared. As a result, the growth of calcium phosphate layer formed on the nitrided sample is the fastest among the samples. These results revealed that biocompatibility of Ti alloy nitrided by atmospheric-pressure plasma was improved.

## 1. Introduction

In recent years, new surface treatment methods have been developed in order to improve biological characteristics of biocompatible metals such as Ti alloy used in the medical field. Several studies have reported that TiN coating and nitriding of Ti alloy improved biocompatibility. For example, Lin *et al.* proposed that TiN layer can inhibit adhesive property of mutans streptococcus [1]. Moreover, Zhao *et al.* indicated that TiN layer improves adhesive property of osteoblast cells which synthesize bone [2]. In this study, we research improvement of the hard-tissue compatibility of Ti alloy nitride by pulsed-arc (PA) atmospheric pressure plasma jet. [3]

## 2. Experimental

### 2.1. PA plasma jet

The sample is Ti-6Al-4V (15×15×4 mm). The experimental system uses PA plasma jet. An external heater surrounds the quartz pipe to control the treatment temperature (1000°C) so that the samples is uniformly heated. The operating gas is N<sub>2</sub>/H<sub>2</sub> gas mixture at the flow ratio of 99:1. Low- frequency voltage pulses (5 kV, 1.2 A, 21 kHz) are applied to the internal electrode, and the external electrode is grounded. This nitriding method is spraying jet plume onto the sample.

### 2.2. Immersion test

To evaluate the formation ability of calcium phosphate in vitro, samples were immersed in simulated body fluid (Hanks' solution) at 37°C for 10 days. In order to prove that nitrided sample have good biocompatibility, calcium phosphate formative ability of four types of samples (control, nitrided, high hydrophilicity, high surface roughness) are compared. In addition, samples are masked to determine formed layer, and thickness of film is measured by laser microscope.

## 3. Results and Discussions

After atmospheric-pressure plasma nitriding, the surface turned to the golden color, corresponding to TiN. Calcium phosphate formed on surface was proved by EDX analysis. Fig. 1 shows comparison of the four types of samples. The growth of calcium phosphate layer of nitrided sample is the fastest among the four samples. In addition, it is revealed that adhesion force of nitrided sample between calcium phosphate layer and substrate is improved. These results implied that atmospheric-pressure plasma nitriding has a high potential to improve the affinity of Ti alloy for osteoblast cells.

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## 4. References

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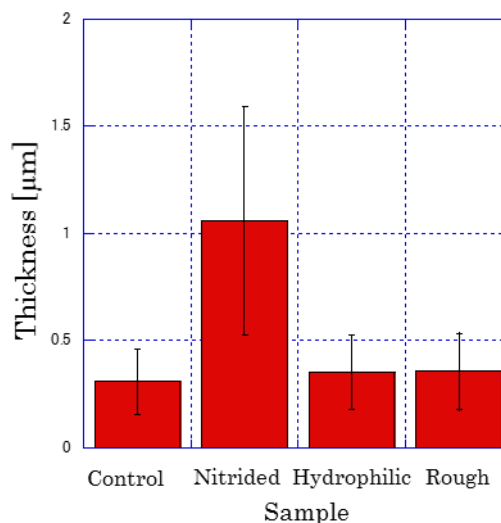


Fig. 1 Thickness of formed calcium phosphate.