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大気圧プラズマジェットによる窒化チタン薄膜の合成
Synthesis of Titanium Nitride using Atmospheric-Pressure Plasma Jet

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Titanium is widely used in medical fields due to good biocompatibility and high corrosion resistance. It is reported that the performance of titanium as a biomaterial was upgraded more by nitriding or TiN coating [1,2]. Compared to coatings, plasma nitriding has a plenty of merits, e,g, hard layer formation, extremely small size distortion, and strong adhesion of nitride layers and substrate. The consequent improvement of mechanical properties such as wear resistance will upgrade titanium further as biomedical components. We have developed a new plasma-jet nitriding technology operated under atmospheric pressure [3,4]. Atmospheric-pressure operation provides the ability of producing dense reactive species and the absence of electric-field concentration in contrast to low-pressure plasmas, which will offer novel nitriding techniques.

Titanium nitride synthesis was performed in an air-tight container to purge the residual oxygen. N_2/H_2 mixture gas (H_2 ratio of 1%) is introduced from the upper part of the coaxial cylindrical electrode nozzle at 20 slm. Low-frequency voltage pulses (4-5 kV, 21 pps, 1 A) are applied to the inner electrode to produce pulsed-arc discharge. The afterglow is spewed out from the orifice, forming the jet plume. We used high-purity titanium JIS TP270 (20×20×4 mm^3). The plasma jet is sprayed onto the center of sample surface as shown in Fig. 1 The duration was 2 h.

Treated samples displayed golden color. Fig. 2 shows a metallographic structure of a treated surface, where we see the formation of two layers. The outermost layer takes golden color. Fig. 3 shows XRD spectra of the treated surface, proving that TiN and Ti_2N are synthesized on titanium. From these facts, it follows that the outermost layer shown in Fig. 2 is a TiN layer and the second one is a Ti_2N layer. In the conference we report dependence of nitride layer synthesis on treatment temperature and the hardness profile of diffusion layers.

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[2] H.-H. Huang *et al.*, Appl. Surf. Sci. **244**, 252 (2005).
[3] H. Nagamatsu *et al.*, Surf. Coat. Technol. **225**, 26 (2013).
[4] R. Ichiki *et al.*, Mater. Lett. **71**, 134 (2012).

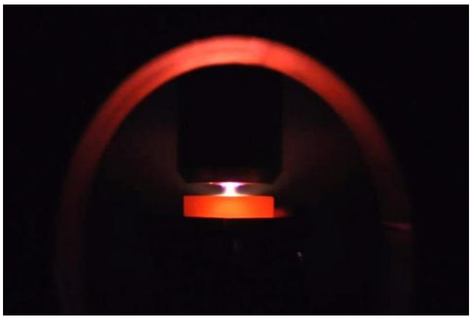

Fig. 1 Photograph of titanium nitride synthesis by spraying atmospheric-pressure plasma jet.

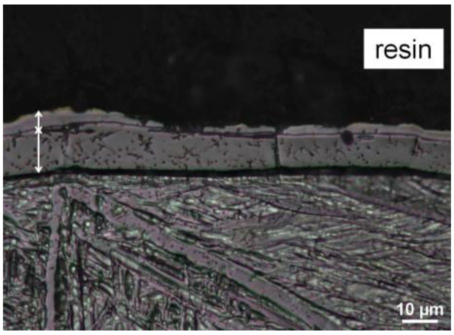

Fig. 2 Titanium nitride thin film synthesized by atmospheric-pressure plasma treatment.

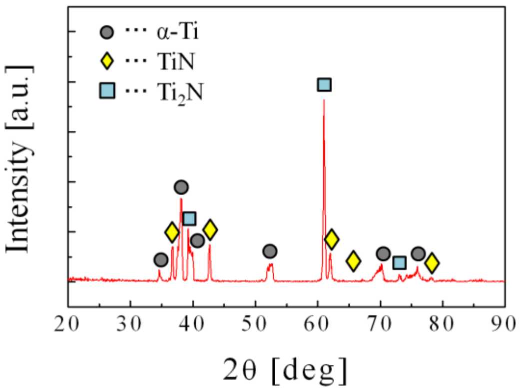

Fig. 3 XRD spectra of treated titanium surface.