# Adhesion strength of hydroxyapatite layer on zirconia substrates coated by droplets eliminated type pulsed-laser deposition

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Zirconia ceramics is a feasible candidate for the base material of the medical implants because of its mechanical properties as hardness and toughness, and biocompatibility. However, zirconia is inferior to pure titanium for bone conductivity. Therefore, hydroxyapatite (HAp) coating on zirconia implants is a crucial subject for strong and early bone-fixing. Weak adhesion of the coating layer and brittleness owing to porous structure cause detachment of the layer during implantation surgery. These peeling edges cause inflammation and impede the bone bonding of the implants. High adhesion of the HAp coating on zirconia substrate is a crucial issue for strong and early bone-fixing especially for dental implants.

Droplets eliminated type pulsed-laser deposition is a feasible candidate to fabricate high-quality HAp coating. High density without holes, high purity, and high crystallinity HAp layer was successfully demonstrated by an eclipse-type pulsed-laser deposition scheme, which was measured by Raman spectroscopy [1]. The crystalline layer can be coated on a zirconia substrate only at 360 ℃, which is the lowest annealing temperature of the in situ annealing and deposition scheme ever reported. Moreover, the crystallinity becomes better as increase the annealing temperature (Ta). This high-quality HAp coating will enhance the new bone formation on the coating surface long period without dissolving in vivo.

We also measured the adhesion strength of the HAp coating on zirconia substrates as a function of Ta by an oscillating micro-scratch tester (RHESCA CSR2000). The critical load intensity as a function of Ta and typical scratched traces were shown in Fig. 1. (A) is an amorphous layer at low annealing temperature, (B) amorphous at high temperature, and (C) crystallin hydroxyapatite over 360 ℃. As an increase of the Ta, adhesion strength becomes stronger. This result indicates that the high-quality and strong adhesion coating layer on a zirconia substrate can be realized at high Ta.

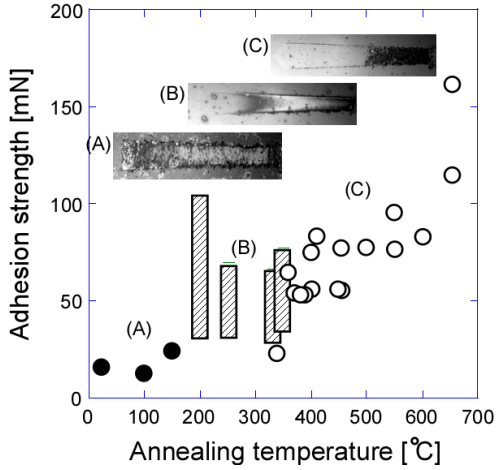


Fig. 1 Adhesion strength of the coating layer as a function of Ta and typical scratched traces for different temperature.

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**References:** [1] H. Yashiro, and M. Kakehata, Appl. Phys. Lett. **120**, 131602 (2022).