

Femtosecond-laser processed CYTOP/Ti with Ag-NPs for SERS measurement

Kazunari Ozasa^{1*}, Shota Kawabata^{1,2}, Shi Bai¹, Kotaro. Obata¹, and Koji Sugioka¹

¹ Advanced Laser Processing Team, RAP, RIKEN, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan

² Tokyo University of Agriculture and Technology, 2-24-16 Nakacho, Koganei, Tokyo 184-8588, Japan

*Corresponding author email: ozasa@riken.jp

We processed the surface of Ti covered with a thin film of fluoropolymer CYTOP [1] to produce laser-induced periodic surface structures (LIPSS). For surface-enhanced Raman spectroscopy (SERS) applications, Ag-NPs were formed on the surface by silver mirror reaction to cover the nano-scales trenches of the LIPSS. Enhancement of Raman peak with a factor of 10^{6-7} was demonstrated on the surface structures.

A thin film of CYTOP with a thickness of 100-800 nm was formed on a Ti substrate by spin coating and heat treatment. Femtosecond (fs) laser (1030 nm) with a pulse width of 220 fs and a fluence of 650 mJ/cm² (50 kHz) was irradiated on the surface through an f θ lens (f = 167 mm) in combination with a 2D Galvano-scanner with a scanning speed of 80 mm/s. The CYTOP layer at the irradiated areas was removed by laser ablation, and LIPSS were formed on Ti surfaces, as shown in Fig. 1. After the laser-processing, Ag-NPs were formed on the surface with silver mirror reaction with AgNO₃ containing solution for 30 s. The surface was covered densely with Ag-NPs with a diameter of approximately 50 nm, as shown in Fig. 2.

Figure 3 shows the Raman spectrum of Rhodamine 6G (R6G) obtained on the surface of Ag-NPs/Ti-LIPSS, with placing a droplet of 1- μ M R6G on the surface and drying. Clear peaks of R6G was obtained only on the LIPSS area. No Raman peaks were observed when Ag-NPs were not formed on the Ti-LIPSS, showing that Ag-NPs on the trenches of LIPSS plays an essential role for SERS. Since CYTOP layer has a high hydrophobicity, Ag-NPs/CYTOP/Ti-LIPSS will be potential for water-based bio-molecule analysis, especially when microchamber array [2] is formed by fs-laser processing with a high throughput scanning.

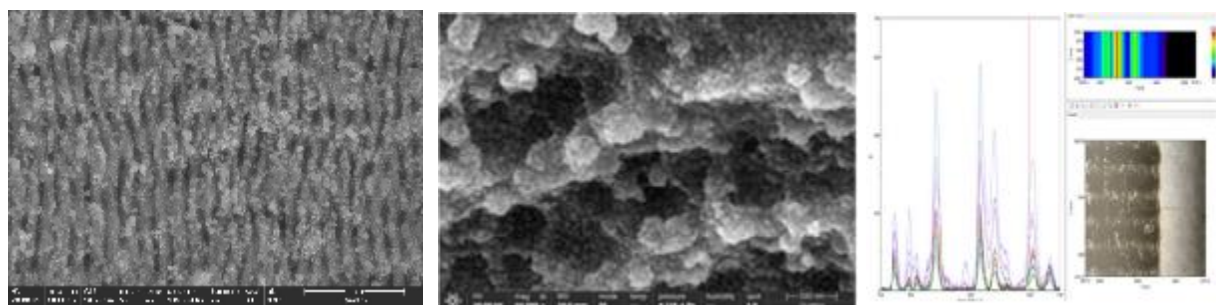


Fig. 1 LIPSS formed on CYTOP/Ti Fig. 2 Ag-NPs on Ti-LIPSS Fig. 3 SERS peaks observed

References:

[1] K. Ozasa, K. Obata, H. Kawano, A. Miyawaki, K. Sugioka, *Adv. Mater. Technol.*, 28, 1706262 (2018)

[2] J. Ando, K. Murai, M. Mori, T. Michiyuki, T. Iida, et al., *Sci. Rep.*, 14, 11442 (2024)