

Micro fluidic device with SERS active nanostructure fabricated on boehmite

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Surface-enhanced Raman scattering (SERS) is a high sensitivity, label-free measurement, and less influence spectroscopic technique that enhances the weak Raman signal by localized surface plasmon resonance (LSPR)(1). Thus, this technique is used for long-term monitoring for bioanalysis and environmental analysis. Especially, we have studied on a method to fabricate SERS-active structures of gold nanofêve using the boehmite structure due to its advantage of easy fabrication on a wide range of substrates such as glass (2). Microfluidic devices incorporating the above SERS structures were fabricated and evaluated for detection processes for application in bioanalysis and environmental analysis. The following is a description of the device fabrication process. First, we fabricated SERS structure on the boehmite by the method shown in Fig. 1(a). Next, the flow channel structure was fabricated by pouring polydimethylsiloxane into a mold master fabricated by a 3D printer. Finally, the surface of boehmite substrate and channel structure were plasma treated and bonded. SERS measurement was demonstrated using the fabricated SERS device. A schematic measurement system is shown in Fig. 1(b). The samples were 4,4'-Bipyridine (4bpy) and pure water. We measured Raman spectra while pumping the samples. In this experiment, 4bpy (20 μ M) and pure water were each pumped at a flow rate of 0.1mL/min for 40 minutes. After this experiment, we pumped pure water at a flow rate of 0.1mL/min for 30 minutes to check the washing efficiency of the sensor.

The measured Raman spectra are shown in Fig. 2(a). We can know that the intensity of the Raman spectrum increases with time. On the other hand, the washing experiment showed a decrease in intensity, but the Raman peaks did not disappear completely shown in in Fig. 2(b). Both results were probably influenced by the strength and amount of adsorption of the sample on the hot spots of the gold nanoparticles. This experiment confirms that the SERS structure can be applied to long-term experiments because the Raman intensity was maintained even after fluid flow for more than 40min.

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² S. Yamazoe, M. Naya, M. Shiota, T. Morikawa, A. Kubo, T. Tani, T. Hishiki, T. Horiuchi, M. Suematsu, and M. Kajimura, *ACS Nano*, 8, 6, 5622–5632, 2014.

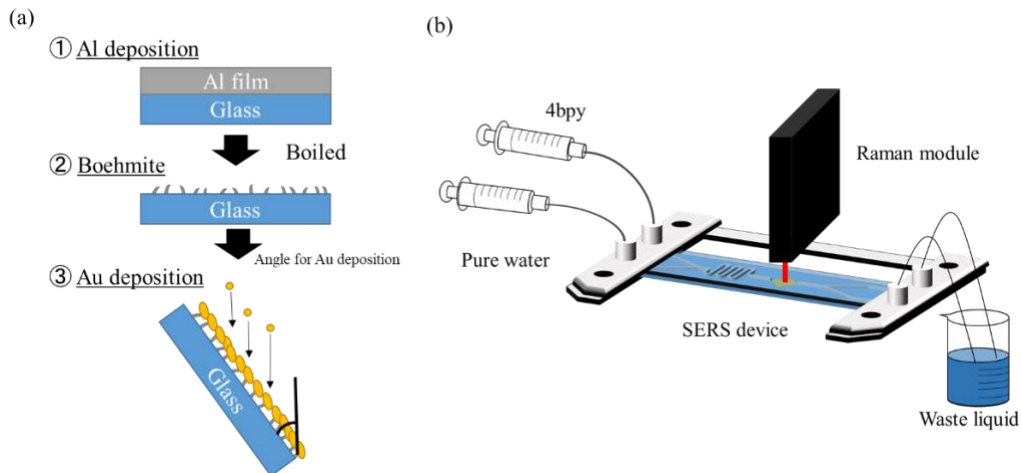


Figure 1: Experimental set up (a) SERS sensor fabrication process: First, an Al layer of 84 nm is formed on a glass slide. After that, the glass substrate is heated in water at 100°C for 10 minutes to make boehmite. Finally, the boehmite substrate is tilted 10 degrees and sputtered about 60 nm of Au. (b) Overview of Microfluidic Devices: 4,4'-Bipyridine (4bpy) and pure water are mixed and pumped using a syringe, and then irradiate the liquid sample with a laser using the Raman spectroscopy module to perform SERS measurements.

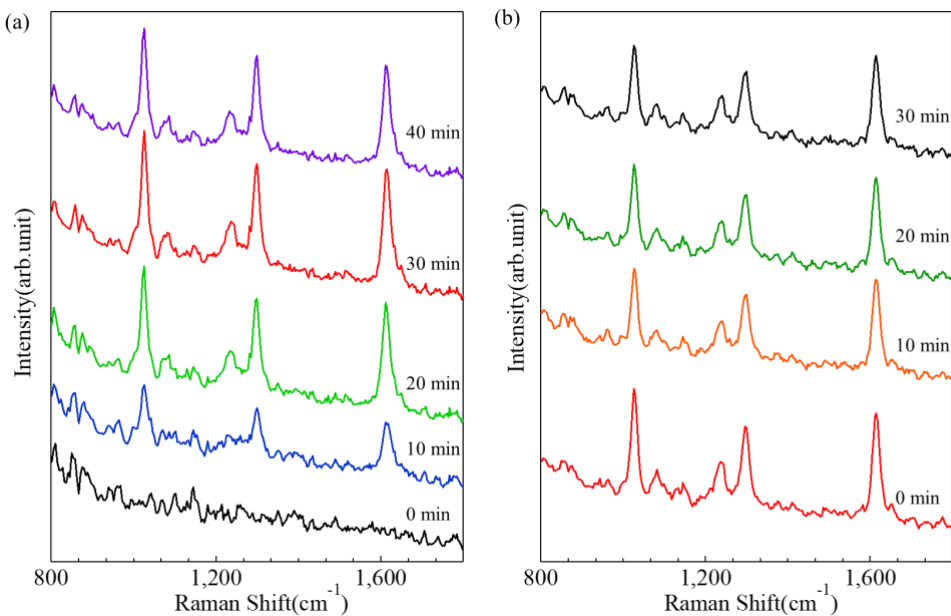


Figure 2: Changes in the intensity of Raman spectra with time (a) Sample measurement: This result is measured while 4bpy (20 μ M) and pure water were each pumped at a flow rate of 0.1mL/min for 40 minutes. The Raman intensity saturates after about 15 minutes. (b) Washing effect: This result is measured while pure water was pumped at a flow rate of 0.1mL/min for 30 minutes after sample measurement. The Raman intensity decreased slightly.