Gold Nanoparticles Sliding on Recyclable Nanohoodoos as SERS Substrates – Bridging the Gap between Low Cost and Excellent Performance

Wu, Kaiyu; Li, Tao; Schmidt, Michael Stenbæk; Rindzevicius, Tomas; Ndoni, Sokol; Boisen, Anja

Publication date: 2018

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Gold Nanoparticles Sliding on Recyclable Nanohoodoos as SERS Substrates – Bridging the Gap between Low Cost and Excellent Performance

Kaiyu Wu1,2*, Tao Li1, Michael S. Schmidt1,2, Tomas Rindzevicius1,2, Sokol Ndioni1, Anja Boisen1,2

1Department of Micro- and Nanotechnology, Technical University of Denmark, Ørsteds Plads, Building 345B, 2800 Kgs. Lyngby, Denmark
2DNRF and Villum Fonden Center for Intelligent Drug Delivery and Sensing Using Microcontainers and Nanomechanics, IDUN, Technical University of Denmark, Ørsteds Plads, Building 345C, 2800 Kgs. Lyngby, Denmark

*Email address:kaiwu@nanotech.dtu.dk

The development of nanostructured surfaces as substrates for surface-enhanced Raman spectroscopy (SERS) has been a hot topic in the field, since the success of SERS in practice relies on the availability of highly enhancing, macroscopically uniform, cheap and reproducible substrates. Herein, I present a novel substrate that might prove advantageous with respect to all the expected properties of an ideal SERS substrate.[1] The substrate consists of gold nanoparticles that can slide and aggregate on dense and recyclable alumina/silicon nanohoodoos, which are fabricated in wafer-scale using block copolymer lithography.[2] The substrate can be used for both gas and liquid sensing. Hot-spot engineering is conducted to maximize its SERS performance. The developed substrate demonstrates remarkably large surface-averaged SERS enhancements, greater than $10^7$ (>10^8 in hot spots), with unrivalled macroscopic signal uniformity as characterized by a coefficient of variation of only 6% across 4 cm. Interestingly, after SERS analyses, the nanohoodoos can be recycled by complete removal of gold via a one-step, simple, and robust wet etching process without compromising performance, minimizing the cost. After 8 times of recycling, the substrate still exhibits identical SERS performance in comparison to a new substrate. Our work facilitates the practical use of SERS for both laboratorial and commercial applications.

Figure 1. a) Schematic of the nanofabrication. b-d) SEM images taken between and after the last 3 process steps in a). e,f) Pictures of 2-inch wafers covered with arrays of nanohoodoos before and after gold deposition, respectively.

References: