Attomolar sensing: Fabrication of surface-enhanced Raman scattering substrate

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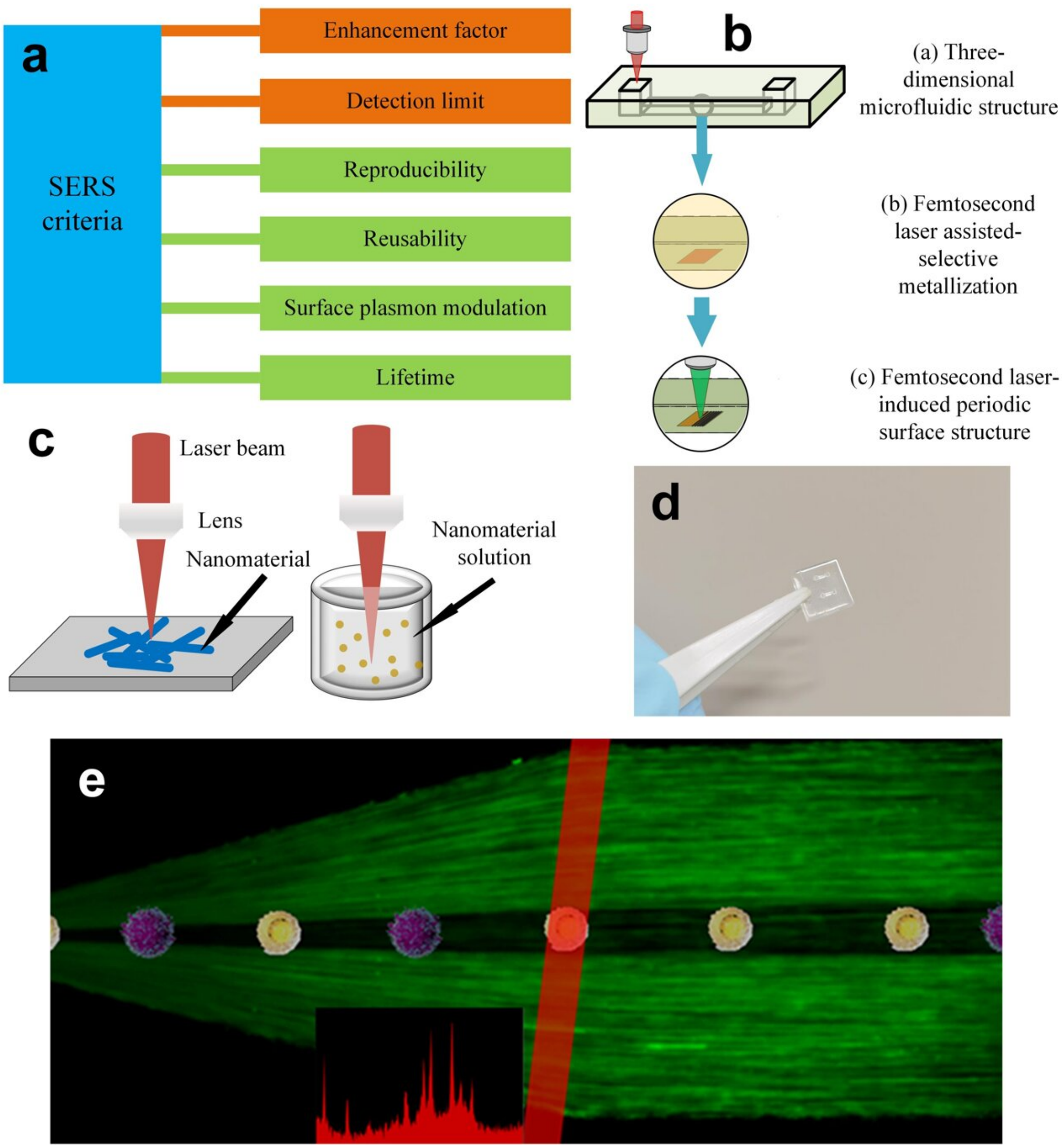

a, The criteria for the evaluation of SERS performance. The enhancement factor and detection limit are the common concerns for assessment of SERS substrates b, The schematic illustrates a 3D glass microfluidic SERS chip fabricated by all-femtosecond-laser-processing. c, Two basic configurations of femtosecond laser-induced nanojoining of nanomaterials for SERS applications. d, A photograph of 3D glass microfluidic SERS chip. e, The schematic of cancer cells identification by SERS in a microfluidic chip in real-time. Credit: Shi Bai and Koji Sugioka

Surface-enhanced Raman scattering (SERS) permits multidisciplinary trace analyses and the potential detection of single molecules. Shi Bai and Koji Sugioka from RIKEN report a comprehensive review of recent progress in strategies for the fabrication of highly sensitive SERS substrates. Femtosecond laser-based techniques are discussed as a versatile tool for the fabrication of SERS substrates. Several approaches are highlighted for enhancing the performance of SERS sensing devices, and real-time sensing and biological applications are reviewed.

In the 1970s, Fleischmann discovered that on noble metallic nanostructure, the Raman scattering of pyridine was enhanced hundreds-fold. Scientists attributed the enhancement to the localized electric field highly amplified near the surface of specific noble metallic nanostructures. Thus, this phenomenon was termed surface-enhanced Raman scattering (SERS). Currently, although the enhancement mechanism of SERS is still in debate, SERS exhibits incomparable abilities for monitoring and sensing with high sensitivity in diverse fields including environment, biomedicine, food security, archaeology, and soil components. Femtosecond laser processing is increasingly attracting attention for use in the fabrication of SERS substrates due to its versatility, flexibility and high resolution.

In a new paper published in *Light Advanced Manufacturing*, a team of scientists, led by Prof. Koji Sugioka and Dr. Shi Bai from Advanced Laser Processing Research Team, RIKEN Center for Advanced Photonics, RIKEN, Japan reviewed the fabrication methods of highly sensitive SERS substrates by femtosecond laser processing and their applications. The paper first gave the commonly used criteria for evaluation of SERS substrates and summarized the calculation methods used to find enhancement factor. The typical technologies of femtosecond laser processing for the fabrication of SERS substrates were then introduced. To realize the attomolar sensing with the SERS substrates, the authors highlighted several strategies employing synergistic enhancement effects. Additionally, the recent applications of SERS for real-time sensing based on microfluidic chips and biomedicine including cell recognition, deoxyribonucleic acid and protein identification were introduced. The authors have concluded that further efforts for not only developing the next generation of SERS substrates with higher enhancement and lower detection limits but also overcoming unresolved issues such as a universal method for calculating the enhancement factor and the stability and robustness of SERS substrates will continue.

More information: Shi Bai et al, Recent Advances in the Fabrication of Highly Sensitive Surface-Enhanced Raman Scattering Substrates: Nanomolar to Attomolar Level Sensing, *Light: Advanced Manufacturing* (2021). DOI: 10.37188/lam.2021.013

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