Remote Excitation Tip-Enhanced Raman Spectroscopy using Plasmonic Nanowire

KU Leuven, Belgium[1], National Chiao Tung University, Taiwan[2],
Hokkaido Univ., RIES[3], Toray Research Center[4],
°Shuichi Toyouchi[1,2], Wannes Peeters[1], Peter Walke[1], Beatrice Fortuni[1], Tomoko Inose[3],
Yasuhiko Fujita[1,4], Steven De Feyter[1], Hiroshi Uji-i[1,3]
E-mail: shuichitoyouchi@nctu.edu.tw

Tip-enhanced Raman spectroscopy (TERS) is a powerful analytical tool to provide chemical and topographic information of surfaces with spatial resolution at nanometer scale. In our previous study, we reported a unique fabrication method of TERS probe, in which chemically synthesized silver nanowires (AgNWs) were utilized as a plasmonic antenna [1]. Our works illustrate that superior TERS probes can be produced in a fast and cost-effective manner by using simple wet-chemistry methods, allowing for reliable and reproducible TERS experiment. Despite of recent developments of TERS probe including our studies, TERS for an opaque non-plasmonic sample is still challenging due to the low enhancement and non-negligible background, resulting in low signal to noise (S/N) ratio. In this study, to improve the S/N ratio, we performed remote excitation TERS by using AgNWs as a plasmonic waveguide (Fig. 1a).

We fabricated gold nanoparticles (AuNPs) on a AgNW probe by using the recently developed site-specific photo-deposition technique (Fig. 1a Insert). The AuNPs can serve as an in-coupling point for launching propagating surface plasmon polaritons [2]. Using the AuNP decorated AgNW probes, TERS was performed for a SiGe fin (200 nm width) having a strain Ge (sGe) thin layer (a few tens of nanometer thickness) on top of the fin. The peak ratio sGe/SiGe was examined for both direct and remote excitation (Fig. 1b). The ratio with remote excitation was 2 times greater than that with direct excitation. Furthermore using remote excitation also improved the spatial resolution. In the presentation, we will demonstrate a mechanochemical characterization of the fin structures by using our AuNP decorated AgNW probes.

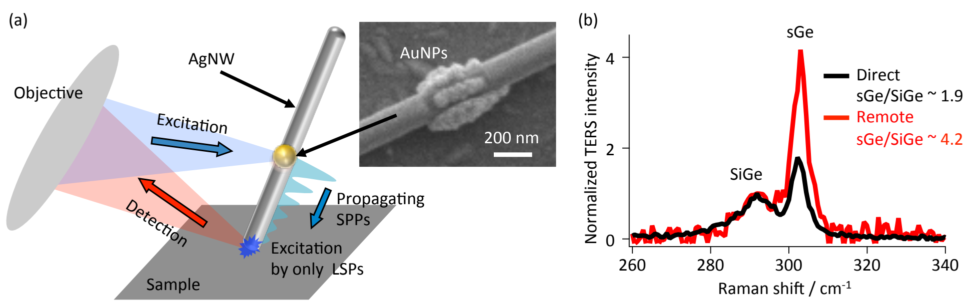

Figure 1. A schematic illustration of the remote excitation TERS. Insert is a SEM image of AuNPs on a AgNW fabricated by using the photo-deposition. (b) TERS spectra of SiGe-sGe fin structure normalized at SiGe peak obtained with direct (black line) and remote excitation (red line).

[1] P. Walke *et al.*, *Nanoscale*, **2018**, *10*, 7556. [2] S. Toyouchi *et al.*, *Nano Lett.*, **2020**, *20*, 2460.