Yoshito Okuno[1]
Marc Chaigneau[2]
[1] HORIBA, Ltd., 2, Kisshoin Miyano-higashi-machi, Minami-ku, Kyoto-shi, 601-8510, Kyoto, JAPAN
[2] HORIBA France SAS, Avenue de la Vauve - Passage Jobin Yvon- CS, Palaiseau 45002, FRANCE

Contact: yoshito.okuno@horiba.com

2D Material Investigations with Tip-Enhanced Raman/Photoluminescence Nanoscopy

Abstract

Two-dimensional transition metal dichalcogenides, the so-called 2D materials, such as MoS_2 and WS_2 have been emerging as a unique material expected to have promising impact on optoelectronics and nanophotonics [1]. For an evaluation of their properties, Raman and photoluminescence investigations with nanometer spatial resolution are regarded as powerful tools. In this report, we introduce the correlated Tip-Enhanced optical spectroscopies (TEOS) such as TERS (tip-enhanced Raman spectroscopy) and TEPL (tip-enhanced photoluminescence) for the characterization of 2D materials including the heterojunction structures[1]. Simultaneous AFM, TERS and TEPL measurements with the laser wavelength of 594 nm are conducted on single layer MoS_2 as shown in Figure 1(a) and Figure 1 (b). During this measurement, a laser power with 440μW and an exposure time by 200ms were set for each point in the imaging. Correspondence was revealed between the topographical map and spectral maps. TERS spectra feature peculiar normal vibration modes of MoS_2 denoted as E_{2g}, A_{1g} and 2LA(M) as shown in Figure 1(c). The MoS_2 flake is a single layer, which is confirmed by the ratio of PL intensity to Raman intensity as shown in Figure 1 (d) and 20 cm^{-1} difference in Raman shift between E_{2g} and A_{1g} mode was observed. Here, we introduced simultaneous tip-enhanced measurements with the combination of Raman and photoluminescence spectroscopy to show their superiority on the investigation of nano-scale characterization.

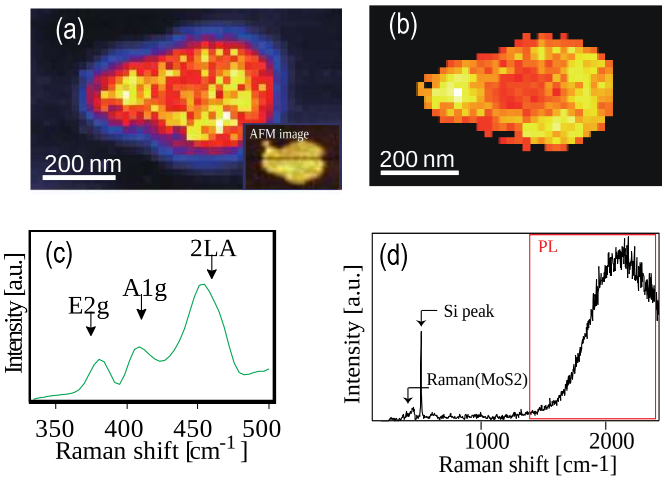

Figure 1. (a) AFM, TERS constructed from integrating signal from 420 to 475cm^{-1}, and (b) TEPL images on a single layer MoS_2 flake taken simultaneously. (c) Normal vibration modes of E_{2g}, A_{1g} and 2LA of TERS spectrum enlarged from (d) typical spectrum of tip-enhanced Raman and PL spectroscopy. Red rectangle represented in (d) shows spectrum area for photoluminescence.

References

[1] Y. Okuno *et al.*, *Nanoscale* **10**(2018), 14055–14059.