Unveiling Defect-Induced Raman Mode of Transition Metal Dichalcogenides Monolayer Using Tip-Enhanced Resonance Raman Spectroscopy

Sungkyunkwan Univ. [1], Korea Research Institute for Standards and Science. [2], ◦Chanwoo Lee[1], Seung Mi Lee[2], and Mun Seok Jeong[1]

E-mail: mjeong@skku.edu

In this presentation, analysis of 2D nanomaterials with Tip enhanced Raman scattering (TERS) will be provided. TERS is a unique tool for investigating Raman scattering mapping with nanometer spatial resolution beyond optical diffraction limit. Using representative tips fabricated under the optimal etching condition, Our lab. demonstrate the TERS experiment of tungsten disulfide (WS_2) monolayer grown by a chemical vapor deposition method with a spatial resolution of ~40 nm. Monolayer WS_2 has emerged as an active material for optoelectronic devices due to its quantum yield of photoluminescence. Despite the enormous research about physical characteristics of monolayer WS_2, the defect-related Raman scattering has been rarely studied. In this work, we report the correlation of topography and Raman scattering in monolayer WS_2 by using TERS and reveal defect-related Raman modes denoted as D and D′ modes. We found that the sulfur vacancies introduce not only the red-shifted A1g mode but also the D and D′ modes by the density functional theory calculations. The observed defect-related Raman modes can be utilized to evaluate the quality of monolayer WS2 and will be helpful to improve the performance of WS_2 optoelectronic devices.

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2. Chanwoo Lee & M.S. Jeong* et al “Tip-Enhanced Raman Scattering Imaging of two-Dimensional Tungsten Disulfide with Optimized Tip Fabrication Process“, Scientific Reports, 7, 40810 (2017).
3. Chanwoo Lee & M.S. Jeong* et al “Unveiling defect-related Raman mode of monolayer WS2 via tip-enhanced resonance Raman scattering “, ACS Nano, 12, 10, 9982-9990(2018)