Graphene2019
June 25-28, 2019 Rome (Italy)

Linearly polarized Raman spectroscopy of ReS$_2$ & ReSe$_2$

Yun Choi$^1$, Keunui Kim$^1$, Jungcheol Kim$^1$, Sooyeon Lim$^1$, Jung Hwa Kim$^2$, Zonghoon Lee$^2$, Hyeonik Cheong$^1$,*

$^1$Department of Physics, Sogang University, Seoul, 04107, Korea
$^2$School of Materials Science and Engineering, Ulsan National Institute of Science and Technology, Ulsan 44919, Korea

yunchoi@sogang.ac.kr

In-plane anisotropy of rhenium dichalcogenides (ReX$_2$, X= S, Se), members of the group-VII transition metal dichalcogenides (TMDs), give additional degrees of freedom in manipulating device properties using anisotropic electronic and optoelectronic properties. The covalent bonding of the transition metal atoms (Re-Re) causes the anisotropic 1T' (distorted trigonal) structure and all axes are not normal to other axes of the crystal. Therefore, up-and-down faces of monolayer ReX$_2$ are not equivalent, and the physical properties are related to the crystallographic orientation [1][2].

In this study, we performed linearly polarized Raman measurements on 1- to 3-layer ReX$_2$ on both up- and down-sides. The thickness was determined by interlayer vibration modes in the low frequency region (< 40 cm$^{-1}$) [3]. We investigated the polarization dependence of the 18 Raman modes with the several excitation wavelengths (442, 514, 532, 633 nm). The polarization dependences of the Raman modes vary with the excitation wavelengths. From the relation of the polarization dependence of two Raman modes (ReS$_2$: 152, 212 cm$^{-1}$ and ReSe$_2$: 125 cm$^{-1}$ and 160 cm$^{-1}$), we classified the sides of the samples corresponding to the two vertical orientations. We also identified the Re-chain direction using the polarization direction of the Raman modes at 212 cm$^{-1}$ (ReS$_2$) and 160 cm$^{-1}$ (ReSe$_2$) by comparing with scanning transmission electron microscopy (STEM) measurements.

References


Figures

Figure 1: Optical images, Polarization dependences and STEM images of 1L ReS$_2$.  
ReS$_2$ (1L, 2.33 eV)

Figure 2: Optical images, Polarization dependences and STEM images of 1L ReSe$_2$.  
ReSe$_2$ (1L, 1.96 eV)