Study on interlayer interactions in MoS_2-ReS_2 heterostructures

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Heterostructures stacked with two different monolayer transition metal dichalcogenides result in moiré superlattices due to the lattice mismatch or rotational misalignment [1]. Although there are many Raman studies on the heterostructure of transition metal dichalcogenide materials, there is a lack of Raman studies on the isotropic-anisotropic heterostructure. Therefore, we conducted a study on the heterostructures of MoS_2 which is an isotropic transition metal dichalcogenide material and ReS_2 which is an anisotropic transition metal dichalcogenide material.

MoS_2 and ReS_2 monolayers were fabricated using the mechanical exfoliation method, and heterostructures were fabricated using the dry-transfer method. MoS_2 has a honeycomb structure and it is consisting of stacks of S-Mo-S sandwiches held together by van der Waals interactions [2]. ReS_2 has an anisotropic structure, 1T', because Re has one more electron that makes a Re-chain [3]. The twist angle of the heterostructure was determined by using polarization-dependent second harmonic generation for MoS_2 and polarization-dependent Raman for ReS_2. By observing interlayer interaction by low frequency Raman, it was confirmed that the two layers are interacting. It was found that the maximum intensity polarization of the mode 5 of ReS_2 varies depending on the twist angle of the heterostructure. Also, new peaks were discovered in the high frequency range of the Raman spectrum which are attributed to moiré phonons.

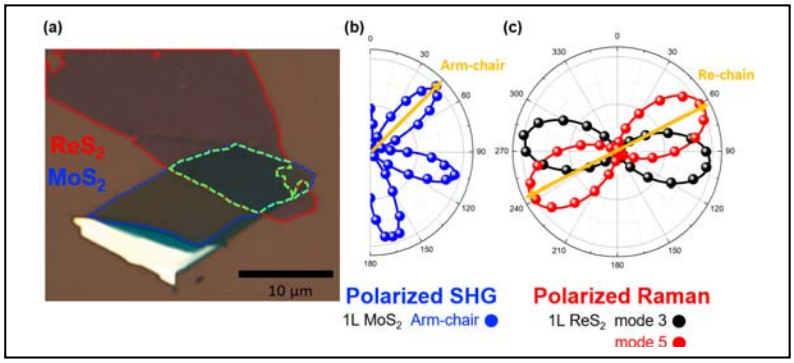

Fig 1.(a) Optical image of MoS_2-ReS_2 heterostructure. **(b)** Polarized SHG signal of MoS_2 **(c)** Intensities of Raman modes 3 and 5 of ReS_2

References

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[3] Sefaattin Tongay *et al., Nature commun.* **5**, 3252 (2014).