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Spectroscopy of exfoliated $NbSe_2$ thin films using $NbSe_2/MoS_2$ superconductor-semiconductor heterostructures

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Owing to the rapidly developing technology of mechanical exfoliation of layered materials and transfer/stacking of atomic layers, first developed in the graphene research, atomically thin superconducting transition metal dichalcogenide $NbSe_2$ has attracted much attention. Peculiar features such as superconductivity in high-quality monolayer with suppressed superconducting energy gap and two-band superconductivity have been reported.[1,2] In such measurements, so-called van der Waals tunnel junctions (stacked superconductor-semiconductor heterostructures) were used. However, it is known that reproducing the above results is quite difficult. Thus, here we focus on the transport property of such van der Waals superconductor-semiconductor heterostructures.

In our experiment, van der Waals $NbSe_2/MoS_2$ heterojunctions were made in a glove box, and Ti/Au electrodes are connected to them to perform tunnel spectroscopy of $NbSe_2$. We find that the superconducting energy gap of $NbSe_2$ derived from the tunnel conductance is generally smaller than the value expected from the BCS theory, and it strongly depends on the thickness of MoS_2 layers, indicating that the tunnel conductance does not correspond to the density of states of $NbSe_2$. Origin of the disagreement will be discussed in the presentation.