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# Simple Preparation of Superconducting $NbSe_2$ Films by Selenization

Van der Waals-layered superconductors are attractive as the model for exploring fundamental physics associated with number of layers, stacking orientation, and strain. These degrees of freedom are crucial factors for manipulating the electron density of status, making them candidates for the superconducting films with tunable transition-temperatures. However, exploring their potential applications is hampered by their limited availability; although layered $NbSe_2$, which is an intrinsic superconductor, have been fabricated by chemical and epitaxial techniques [1], the reliable production of well-defined $NbSe_2$ films still remains a significant challenge.

Here we report a simple preparation of superconducting $NbSe_2$ films by selenizing Nb layers. This approach enables the controlled growth of large-area and uniform $NbSe_2$ films with a certain thickness at desired position, allowing for the design of functional devices. Fig. 1a displays the temperature-dependence of the sheet resistance $R_s$ at different thickness of precursor Nb layers. The superconducting transitions with zero resistance were observed at the films prepared from Nb layers with the thickness of 20 nm. Atomic force microscopy reveals that the surface structures of the as-grown $NbSe_2$ films are essential for the occurrence of their superconductivity (Fig. 2a). More importantly, the superconducting $NbSe_2$ films cannot be destroyed under the critical magnetic filed of >9 T (Fig. 1b), which is larger than that of layered $NbSe_2$ (4 T) [2]. Detailed discussion will be presented in the conference.

## References

[1] T. Hotta et al., Appl. Phys., 109 (2016) 133101
[2] X. Xi et al., Nat. Phys., 12 (2015) 139

## Figures

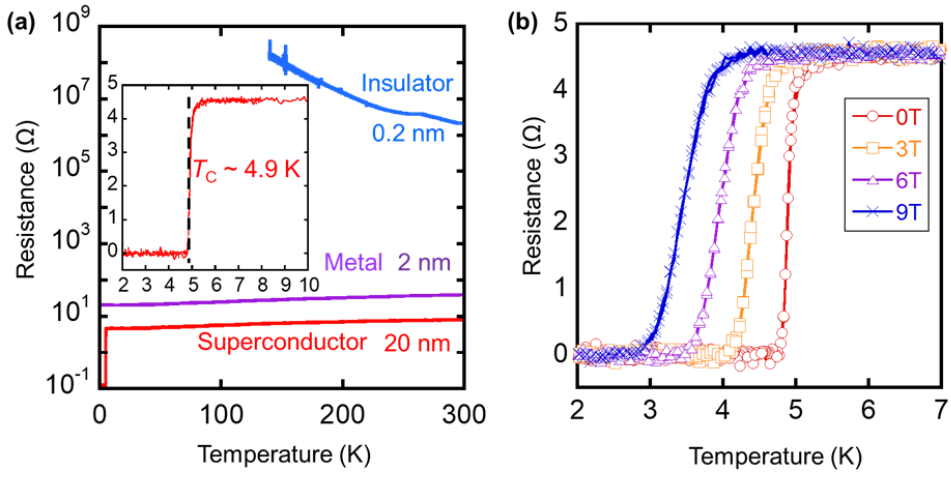


**Figure 1:** (a)Temperature dependence of the resistance for different thickness(0.2, 2 and 20 nm) of precursor Nb layers. (b)Temperature dependence of the resistance of superconducting $NbSe_2$ film under different magnetic field.

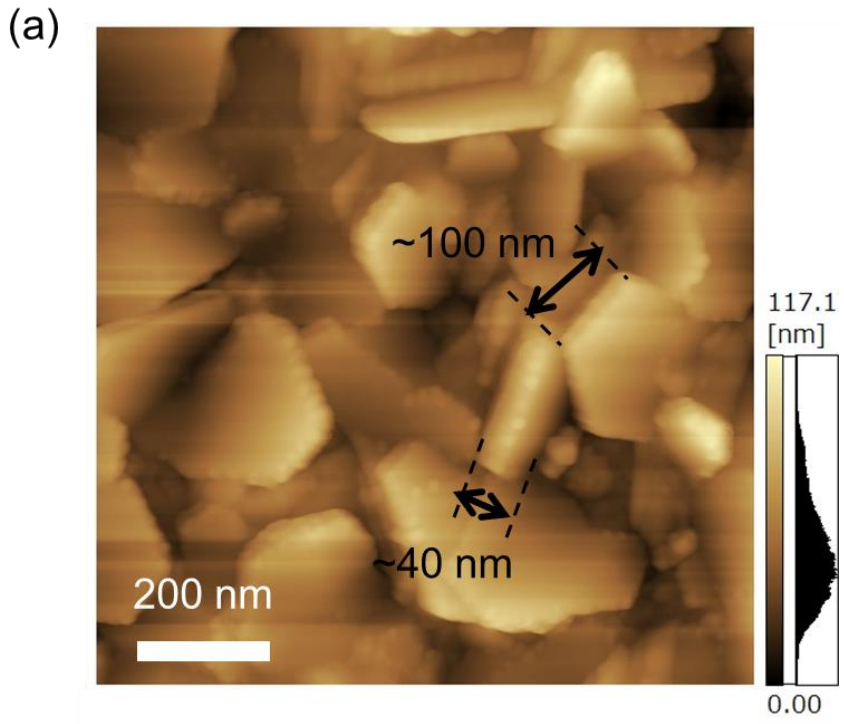


**Figure 2: (a)**AFM image of superconducting $NbSe_2$ film.