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Effect of Microfabrication on Electronic Transport Properties of Exfoliated $NbSe_2$ Thin Films

In recent years, exfoliation techniques developed for the research of graphene have been applied to other metallic, semiconducting, and superconducting layered materials, and novel properties such as quantum metallic phases in highly-doped superconductors have been revealed. In most researches conducted so far, cleaved films with random shape were used without further shape processing. However, for the detailed study of intrinsic physics as well as for device applications, shape processing is indispensable. Here, we investigate the influence of the microfabrication on superconducting properties of exfoliated $NbSe_2$ thin films. We focus on the focused ion beam (FIB) milling and reactive ion etching (RIE).

For the FIB milling, we observed significant decrease of the residual-resistance ratio (RRR), indicating the formation of defects by the FIB. Although clear superconducting transition was seen before the FIB microfabrication, after FIB it was blurred. We speculate that the film thinning occurred due to the FIB milling.

For the RIE, the resulting thin wire with width of 2.0 and 0.5 μm exhibited superconducting transition at temperatures which are almost the same as those for films without microfabrication. However, in the current-voltage characteristics of 0.5-μm wires, the Bloch-nose like structure around the origin and significant increase of the phase-slip induced voltage jumps were seen, indicating the existence of the RIE-induced phase-slip centers.