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Micro-Fabrication of NdFeAs(O,F) Thin Films and Evaluation of the Transport Properties for Future Particle-Detector Application

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Photon and ion detectors based on superconducting nanowires have been attracting substantial attention because they are superior to conventional detectors in terms of high-speed operation, high sensitivity, and low noise characteristics. To realize these excellent performance, the superconductor has to be fabricated into narrow wires with a width of about 300 nm for an ion detector and 100 nm or less for a photon detector. Detectors based on conventional BCS superconductors such as Nb and NbN have been already extensively studied [1]. However, the operating temperature is low due to their low transition temperature (T_c). As for the high-T_c superconductors, there are several attempts to fabricate detectors from MgB_2 and copper-oxides [2-4], yet they suffer from a notable degradation of the superconducting characteristics when the wires become narrow. On the other hand, little is known about the performance of nanowires based on iron-based superconductors. In this work, we fabricated narrow wires from thin films of NdFeAs(O,F), which has the highest T_c (= 56 K) among iron-based superconductors, and evaluated their transport properties.

High-quality single crystalline thin films of NdFeAs(O,F) were grown on MgO substrates by a molecular beam epitaxy method [5]. The film was patterned into a two-island structure connected by a narrow wire (40-nm-thick x 0.35-µm-wide x 10-µm-long) using i-line lithography and Ar ion milling. The as-grown film exhibited a zero T_c of 40 K, whereas the fabricated wire still kept T_c = 38 K as displayed in Fig. (a). The critical current density (J_c) was 1.3 MA/cm^2 at 4 K as shown in Fig. (b). These results indicate that degradation of the superconducting properties of NdFeAs(O,F) due to nano-processing might not be as serious as other high-T_c superconductors.

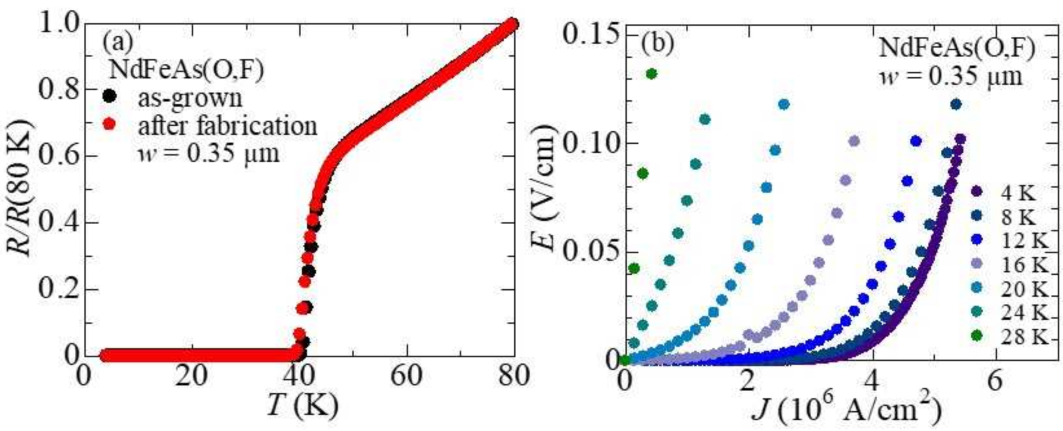

Fig. (a) Temperature dependence of the resistivity, and **(b)** current density (J) dependence of the electric field (E) of the fabricated wire. The data of the as-grown film are also shown in (a).

[1] C. M. Natarajan *et al.*, *Supercond. Sci. Technol.* **25**, 063001 (2012). [2] H. Shibata *et al.*, *Appl. Phys. Lett.* **97**, 212504 (2010). [3] N. Zen *et al.*, *Appl. Phys. Lett.* **106**, 222601 (2015). [4] R. Arpaia *et al.*, *Phys. Rev. B* **96**, 064525 (2017). [5] T. Kawaguchi *et al.*, *Appl. Phys. Lett.* **97**, 042509 (2010). T. Kawaguchi *et al.*, *Appl. Phys. Express.* **4**, 083102 (2011).

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