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Fabrication of superconducting NdFeAs(O,H) epitaxial thin films

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*Ln*FeAs(O,F) (*Ln*: lanthanide) exhibits the highest superconducting transition temperature (T_c) up to 58 K among the Fe-based superconductors. However, the amount of F that can be substituted for O is limited to about 20% and it is difficult to investigate the physical properties in the overdoped region. On the other hand, Hanna *et al.* reported that the substitution limit can be increased to about 80% by changing the substituting elements from F to H[1]. Furthermore, SmFeAs(O,H) epitaxial thin films on MgO (001) substrates were grown recently using a topotactic reaction SmFeAsO + (x/2)CaH_2 → SmFeAs($O_{1-x}H_x$) + (x/2)CaO[2]. It is interesting whether *Ln*FeAs(O,H) thin films for other *Ln* can be realized. Here, we report on the fabrication of NdFeAs(O,H) thin films using the same H doping method[2], and their structural and electromagnetic properties.

Parent NdFeAsO thin films having a thickness of 20 - 30 nm were grown on MgO (001) substrates by molecular beam epitaxy[3]. The NdFeAsO film and CaH_2 powder were sealed in an evacuated quartz tube. The whole arrangement was then annealed under various conditions. Figure 1 (a) and (b) show the results of X-ray diffraction (XRD) measurement and the temperature dependence of resistance for one of the NdFeAs(O,H) films. For comparison, the data of an as-grown film are also shown. From the XRD measurements, no impurities were observed both for as-grown and annealed films. The 00*l* peaks shifted to higher angles. The *c*-axis length changed from 8.587 Å to 8.466 Å. These results suggest that a phase-pure NdFeAs(O,H) film was obtained. The resistance measurement showed an onset T_c of 48 K and zero resistance at 45 K, respectively. The magnetization measurements exhibited a self-field critical current density of over 8 MA/cm^2 at 4 K, which is roughly comparable to our NdFeAs(O,F) films.

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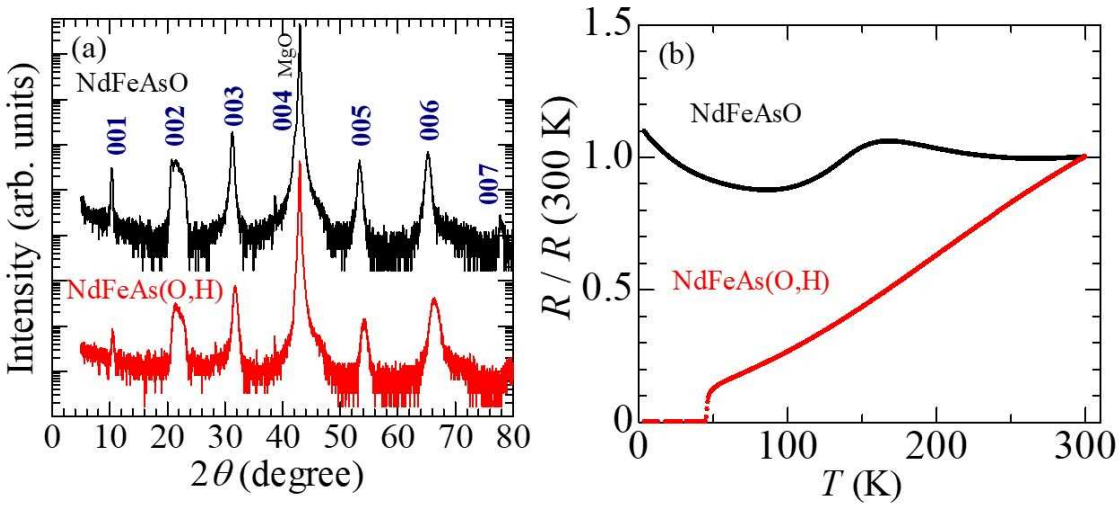

Fig.1. (a) XRD patterns and (b) the temperature dependence of resistance of non-doped and doped NdFeAs(O,H) thin films.

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