Electron Doping into La doped Sr_2IrO_4 by Hydrogen Ion Beam Irradiation

([1]*Fac. of Sci. Kyoto Univ.*, [2]*Dept. of Chemistry The Univ. of Tokyo*, [3]*Inst. of Industrial Science The Univ. of Tokyo*, [4]*Fac. of Sci. Ochanomizu Univ.*, [5]*NSEC JAEA*) ○Y. Yamashita,[1] M. Maesato,[1] G. Lim,[1] A. Chikamatsu,[2 4] T. Hasegawa,[2] T. Ozawa,[3] M. Wilde,[3] K. Fukutani,[3 5] H. Kitagawa[1]

Keywords: Hydrogen ion beam, Iridate, Transport property

Iridates have the potential to exhibit unique electronic properties because of the relatively large spin-orbit coupling with same energy scale of the electron correlations. As a typical example, Sr_2IrO_4 is considered to be an exotic J_{eff} = 1/2 Mott insulator[1] and has some similarities to the parent compound of high-temperature superconducting cuprates. Theoretical studies on the possible unconventional superconductivity of carrier-doped Sr_2IrO_4 have encouraged experimental researches.[2] However, the superconductivity has not yet been observed experimentally in the layered iridates. Recently, we performed hydrogen ion beam irradiation into Sr_2IrO_4 thin film and observed a large decrease in electrical resistivity due to high-density electron doping, but neither a metallic behavior nor a superconducting transition was observed.[3] Here we report on the effects of the La substitution in Sr_2IrO_4 on hydrogen implantation.

Thin films of $Sr_{2-x}La_xIrO_4$ (x = 0.01, 0.03, 0.05, 0.10) were deposited on $(LaAlO_3)_{0.3}(SrAl_{0.5}Ta_{0.5}O_3)_{0.7}$ (LSAT) (001) substrates by pulsed laser deposition (PLD) under the partial oxygen pressure (P_{O2}) of 1 mTorr at the substrate temperature of 800 ℃. Hydrogen was implanted into the $Sr_{2-x}La_xIrO_4$ films at 100 K with an acceleration voltage of 2.0 kV. The dose of hydrogen was estimated by the ion current. We performed *in situ* electrical transport measurements and observed a large decrease in resistivity after the irradiation. In addition, the resistivity further decreased irreversibly when the sample was heated to room temperature and cooled again. The ex-situ Hall effect measurement revealed an increase in n-type carrier of $Sr_{2-x}La_xIrO_4$. The carrier density was found to be nearly constant regardless of the La concentration. Furthermore, in order to investigate the correlation between the concentration of hydrogens and the La concentration, we carried out nuclear reaction analysis. It revealed the less concentration of hydrogen in the La-substituted Sr_2IrO_4 than that in non-substituted Sr_2IrO_4.

1) B. J. Kim, *et al.*, *Phys. Rev. Lett* **101**, 076402 (2008). 2) H. Watanabe, *et al.*, *Phys. Rev. Lett* **110**, 027002 (2013). 3) Y. Yamashita, *et al.*, *Phys. Rev. B* **104**, L041111 (2021).