(Eu,Ca,La)(Fe, Co)As_2 single crystal growth and investigation of physical and superconducting properties

Sugali Pavan Kumar Naik[1,2]*, Sala Alberto[2], Kunimitsu Kataoka[2], Yoshito Gotoh[2], Kenta Hongo[3], Ryo Maezono[3], Taichiro Nishio[1], Hiraku Ogino[2]
*lead presenter: spavankumarnaik@yahoo.in and drspkn@rs.tus.ac.jp

[1] Tokyo University of Science (TUS), Japan
[2] National Institute of Advanced Industrial Science and Technology (AIST), Japan
[3] Japan Advanced Institute of Science and Technology (JAIST), Japan

Abstract: A novel 112-type (AE_{1-x},RE_x)$FeAs_2$ (AE=Ca, Eu, RE = rare earth elements) iron-based superconductor with monoclinic crystal structure was recently reported with the superconducting transition temperature (T_c) of up to from ~10 K – 47 K [1]. Among, the intriguing relationship between antiferromagnetic and superconductivity in 112 compounds along with the anisotropic interaction between Eu^{2+} and Fe^{2+} makes these systems very interesting [2]. During investigating the effect of carrier doping of the compound, we found that relatively large single crystals of this material are formed by high-temperature sintering. Present work deals with the growth of (Eu,Ca,La)(Fe,Co)As_2 (EuCaLa112) single crystals and investigation of their physical and superconducting properties. EuCaLa112 single crystals of larger than 2 mm were successfully grown (Fig. 1). Compared to the parent compound of $EuFeAs_2$, the effective substitution of Ca shrunk the *c*-axis, and further decreased by La/Co co-doping. The magnetic and electric field dependance properties indicate that the EuCaLa112 superconductors are hard superconductors with onset of T_c of ~33 K. All samples exhibited anti-ferromagnetic transition in field dependance measurements, indicating further optimization of Co doping may enhance the superconductivity in these compounds. *M-H* scans at different temperatures measured for determining the lower critical field (B_{c1}). Field dependance of electrical resistivity (Fig. 2) measurements and applying Ginzburg Landau (GL) and Werthamer, Helfand, and Hohenberg (WHH) theories, the upper critical fields (B_{c2} (0)) of the EuCaLa112 superconductor was estimated to be ~37 T. The growth/sintering temperature effect on the microstructure, phase and physical properties modification of EuCaLa112 compounds will be discussed. The new series of Eu containing iron-based superconductors with high T_c may bring interesting playground in this field.

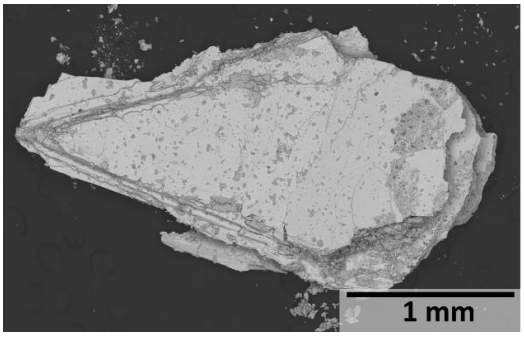

Fig. 1. Scanning electron microscopy image of the EuCaLa112 single crystal

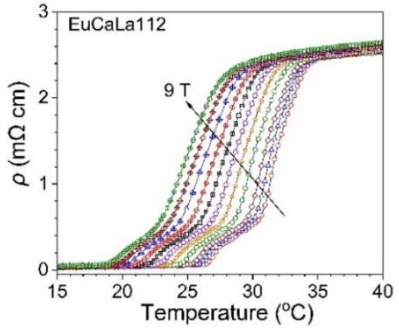

Fig. 2. Field dependance of electrical resistivity of EuCaLa112 singe crystal

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[2] J. Yu, et al., Sci. Chin. Phys. 64 (2021) 267411