Comparative Studies of Quasi-One-Dimensional Superconductivity in $\text{Sc}_5\text{Ir}_4\text{Si}_{10}$ and $\text{Lu}_5\text{Ir}_4\text{Si}_{10}$

TSUYOSHI TAMEGAI, GUOJI LI, Department of Applied Physics, The University of Tokyo — Compounds with a formula $R_5T_4X_{10}$ ($R=$ Sc, Y, rare earth elements, $T=$ Co, Ir, Rh, Os, $X=$ Si, Ge) crystallize in $\text{Sc}_5\text{Co}_4\text{Si}_{10}$-type structure with Sc-Si chains running along the $c$-axis. Some of them show superconductivity with relatively high transition temperatures and coexistence of superconductivity and charge-density wave. We have grown high quality single crystals of $\text{Sc}_5\text{Ir}_4\text{Si}_{10}$ and $\text{Lu}_5\text{Ir}_4\text{Si}_{10}$ using the floating-zone method. Thus obtained crystals show superior properties compared with polycrystalline materials, such as higher $T_c$ and $H_{c2}$. Anisotropic superconducting properties in these crystals are studied in detail. The upper critical field shows clear anisotropy, with $H_{c2}^c > H_{c2}^{ab}$, consistent with the quasi-one-dimensional crystal structure. Both compounds have modest anisotropies with $\gamma = H_{c2}^c/H_{c2}^{ab} = 2.3$ for $\text{Sc}_5\text{Ir}_4\text{Si}_{10}$ and $\gamma = 1.6$ for $\text{Lu}_5\text{Ir}_4\text{Si}_{10}$. Magnetic penetration depths in $\text{Sc}_5\text{Ir}_4\text{Si}_{10}$ ($\lambda_c = 900$ A and $\lambda_{ab} = 2100$ A) estimated from the magnetic field dependence of the equilibrium magnetization confirm quasi-one-dimensional nature of the superconducting state.