High-pressure crystal growth of *Ln*FeAsO (*Ln*=rare earth)

N. D. Zhigadlo, S. Katrych, Z. Bukowski, P. J. W. Moll, K. Rogacki, J. Karpinski, and B. Batlogg

Laboratory for Solid State Physics, ETH Zurich, 8093 Zurich, Switzerland

Further progress in understanding the nature of superconductivity in the Fe-based compounds depends crucially on the availability sufficiently large single crystals of high-quality. Till now, crystal growth of *Ln*FeAsO oxypnictides (*Ln*-1111 with *Ln*=rare earth) has proven to be a difficult task. We adopted the high pressure method and carried out a systematic investigation of the parameters controlling the growth of crystals, including the thermodynamic variables (T, P), reagent composition and kinetic factors, such as reaction time and cooling rate. NaCl/KCl, NaAs, and KAs fluxes were used to grow *Ln*-1111 crystals at a pressure of 30 kbar. From NaCl/KCl flux, crystals with linear sizes up to 300 μm were reproducibly obtained. The reaction time was one of the key parameter that influences the crystal size. Millimeter-sized superconducting Nd-1111 and Sm-1111 single crystals were successfully grown from NaAs and KAs fluxes. This crystal growth starts with a 2 h dwell at 1450 ^{o}C, followed by a slow cooling (4-5 ^{o}C/h) to 1150 ^{o}C, and a final to room temperature within 2 h. The size of *Ln*-1111 crystals suggests that liquid NaAs or KaAs are sufficiently effective solvents, and allow oxygen to diffuse at high temperatures. In addition to substituting F for O, superconductivity has also been induced by substituting Th for Sm, Co for Fe, and P for As. Studies of the crystal structure confirmed high structural quality, and show modifications due to substitutions, which are linked to superconducting properties. The magnetic and transport properties of *Ln*-1111 crystals are compared with other Fe-based pnictides.