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Crystal growth and detailed structural characterization of superconducting and non-superconducting phases in the $K_{1-x}Fe_{2-y}Se_2$ system DANIEL SHOEMAKER, DUCK YOUNG CHUNG, MELANIE FRANCISCO, HELMUT CLAUS, SEVDA AVCI, Argonne National Laboratory, ANNA LLOBET, Lujan Neutron Scattering Center, Los Alamos National Laboratory, HEFEI HU, JIANMIN ZUO, University of Illinois at Urbana-Champaign, MERCOURI KANATZIDIS, Argonne National Laboratory and Northwestern University — Amid the flurry of activity on $K_{1-x}Fe_{2-y}Se_2$ superconductors, it remains established that the stoichiometric compound $K_2Fe_4Se_5$ is an antiferromagnetic semiconductor. This raises the question of whether subtle $Fe^{1+/3+}$ doping causes $K_{1-x}Fe_{2-y}Se_2$ to become a bulk superconductor, and if so, is there a structural distinction between superconducting and non-superconducting phases? We have grown $K_{1-x}Fe_{2-y}Se_2$ samples that show superconductivity with $T_C = 31$ K, even when growth conditions are starkly different from those reported in the literature. Here we present high-resolution synchrotron X-ray diffraction measurements, alongside single-crystal x-ray and electron diffraction, to elucidate the phase space in this system. Combined with magnetometry, heat capacity, and transport measurements, our structure-property relations help prescribe how chemical composition and heat treatment induce superconductivity and vacancy ordering in the $K_{1-x}Fe_{2-y}Se_2$ system.

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