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Synthesis of the Mother Phase of the Iron-Based Superconductor, SmFeAsO via Low-Temperature Heat Treatment

*Ryosuke Sakagami[1,2], Simon R. Hall[2], Jason Potticary[2], Masanori Matoba[1], Yoichi Kamihara[1,2,3]

Department of Applied Physics and Physico-Informatics, Faculty of Science and Technology, Keio University, Japan[1]
Complex Functional Materials Group, School of Chemistry, Univ. of Bristol, United Kingdom[2]
Center for Spintronics Research Network (CSRN), Keio University, Japan[3]

Low-temperature heat treatment of the iron-based superconductor[1,2] is effective for fabrication of the iron-based superconducting wires and tapes with high transport critical current density. To determine the lowest temperature for the formation of a crystallographic phase of SmFeAsO, we demonstrate the evolution of the SmFeAsO during a solid-state reaction in a mixture of SmAs, Fe_2As, FeAs, and Sm_2O_3 heated to heat-treatment temperatures from 580°C to 950°C. X-ray diffraction (XRD) measurements indicated that a significant increasing of the SmFeAsO phase appears at heat-treatment temperatures not lower than 620°C. Scanning electron microscopy (SEM) with energy-dispersive X-ray spectroscopy (EDX) analysis showed a compound uniformly composed of samarium, iron, arsenic, and oxygen (Sm-Fe-As-O) having surface areas on the order of 10 μm^2 surrounded by grains of SmAs, Fe_2As, FeAs, and Sm_2O_3 in a sample heated to 580ºC. This work therefore shows the SmFeAsO phase grows at 620°C and suggested that the SmFeAsO phase emerge at 580°C.

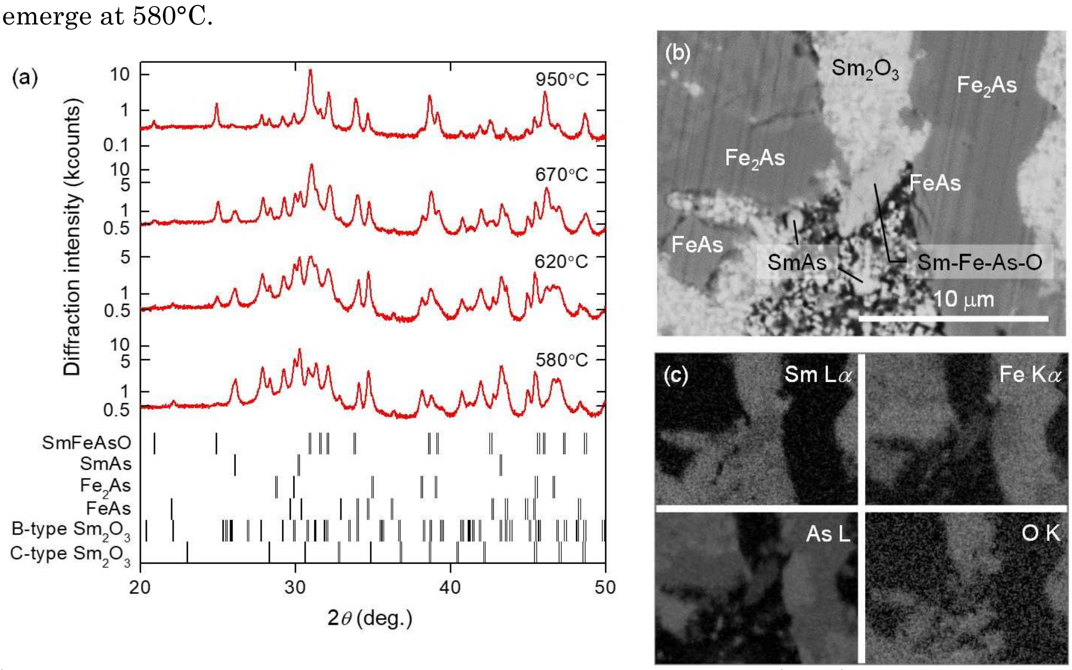

Fig. (a) Heat-treatment temperature dependence of X-ray diffraction (XRD) patterns at room temperature of the pulverized samples heated from SmAs, Fe_2As, FeAs, and Sm_2O_3 as starting materials. The vertical bars at the bottom represent diffractions due to SmFeAsO, SmAs, Fe_2As, FeAs, B-type Sm_2O_3, and C-type Sm_2O_3 from above. Heat-treatment temperatures are denoted near the patterns. (b) Back-scattered electron (BSE) scanning electron microscope (SEM) image and (c) energy-dispersive X-ray spectroscopy (EDX) elemental mapping of a polished sample heated to 580°C from SmAs, Fe_2As, FeAs, and Sm_2O_3 as starting materials.

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