

Cage Network Structure and Superconductivity in Electron-Doped $12\text{CaO}\cdot 7\text{Al}_2\text{O}_3$ and High-Pressure Superconducting Phase of Alkali/Alkaline Earth Metal

Hideo Hosono, Sung Wang Kim, and Satoru Matsuishi,

Frontier Research Center, Tokyo Institute of Technology, Yokohama 226-8503, Japan

Superconductivity is the most clear cut physical phenomena among a variety of electric properties in condensed matters. This year corresponds to the centennial anniversary since the discovery of superconductivity in mercury by Onnes and recent discovery of iron pnictide superconductor has rekindled vital research.¹⁾

It is known that *s*-block elements such as alkali metals do not show superconducting transition (SCT) under ambient pressure, but their high-pressure phases accompanying structural transition by symmetry-breaking exhibit the SCT. Contrary to this fact, electron-doped $12\text{CaO}\cdot 7\text{Al}_2\text{O}_3$ (C12A7:e^-), in which the conduction electrons with *s*-like nature occupy the inherent subnanometer-sized cages, exhibits the SCT at ambient pressure²⁾. Here we report that the cage network structure embracing sub-nanometer-sized space in C12A7 is responsible for the SCT. We show that the electronic structure, probed by Seebeck coefficient measurements and *ab initio* calculations, explains the SCT through the electronic charge transfer from *s*- to *d*-state at the Fermi level (E_F), analogous to high pressure-induced superconducting cI16 phases of alkali Li with the electronic transition from *s*- to *p*-state and the appearance of pseudogap at E_F . This accordance of electronic features originates from the close similarity of their crystal structures, i.e. the Ca-sublattice structure of C12A7 cage at ambient pressure and cage-like polyhedron structure of cI16-Li phase at high pressure. The present findings suggest that the low symmetry cage network structure embracing sub-nanometer-sized space is the key for the realization of SCT in a simple *s*-band metallic material.

1) Y. Kamihara, T. Watanabe, M. Hirano, H. Hosono, *J. Am. Chem. Soc.* **130**, 3296 (2008).

2) M. Miyakawa, S. W. Kim, S. Matsuishi, T. Kamiya, M. Hirano, and H. Hosono, *J. Am. Chem. Soc.* **129**, 7270 (2007).

