High-Tc superconductivity found under high pressure

June 24 2015

Figure 1. The $(NH_3)_yCs_{0.4}FeSe$ sample prepared by liquid ammonia technique.

Drastic enhancement of superconducting transition temperature (Tc) can be induced by placing materials under high pressure, state Yoshihiro

Kubozono and his team at Okayama University.

In previous studies, Metal-intercalated FeSe's prepared using liquid ammonia technique showed very high Tc of 30 - 45 K. With an increase in FeSe plane spacing (d), the Tc increased rapidly, showing that the increase in two-dimensionality leads to the higher Tc.

Until recently, the limit of Tc was recognized as 45 K, because of a saturation of Tc – d plot. Sun et al. conducted a study during which, in the pressure-induced high-Tc superconducting phase for two metal doped FeSe materials ($Tl_{0.6}Rb_{0.4}Fe_{1.67}Se_2$ and $K_{0.8}Fe_{1.7}Se_2$), the maximum Tc reached 48 K. However, such behavior has rarely been reported because it is extremely difficult to conduct the necessary experiments.

In a recent study, Kubozono and his team applied high-pressure to ammoniated Cs doped FeSe ($(NH_3)_yCs_{0.4}FeSe$)) material. They measured the temperature dependence of resistance under pressures of between 0 – 41 GPa.

The Tc of $(NH_3)_yCs_{0.4}FeSe$ (31 K at ambient pressure) gradually decreased with increasing pressure, and no superconductivity was observed down to 4.2 K at 11 - 13 GPa. The superconductivity reemerged rapidly above 13 GPa, and a dome-like pressure-dependence of Tc was found at 15 - 41 GPa. The maximum Tc reached 49 K at 21 GPa.

The emergence of high-Tc phase under high pressure may be characteristic for all metal doped FeSe materials, which may provide a hint for realizing higher Tc superconductors in two-dimensional layered materials in future.

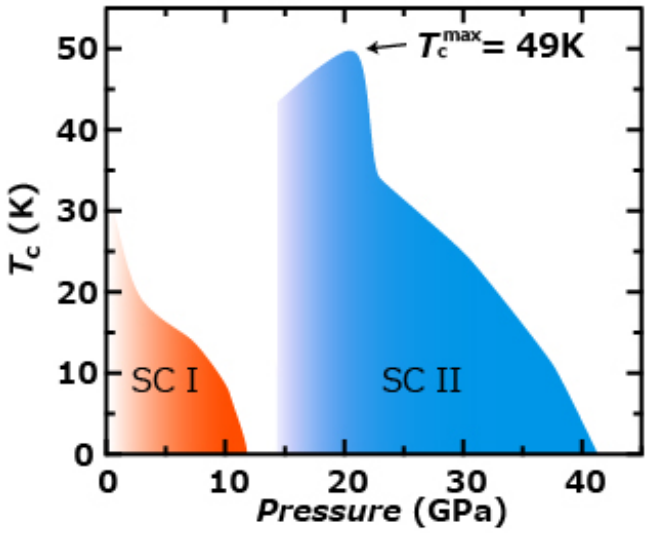

Figure 2: Phase diagram of $(NH_3)_yCs_{0.4}FeSe$.

More information: Emergence of double-dome superconductivity in ammoniated metal-doped FeSe, *Scientific Reports* 5, Article number: 9477 DOI: 10.1038/srep09477

"New Intercalation Superconductor $Li_x(C_6H_{16}N_2)_yFe_{2-z}Se_2$ with a Very Large Interlayer-Spacing and Tc = 38 K." *J. Phys. Soc. Jpn.* 83, 113704 (2014) DOI: dx.doi.org/10.7566/JPSJ.83.113704

"Re-emerging superconductivity at 48 kelvin in iron chalcogenides." *Nature*. 2012 Feb 22;483(7387):67-9. DOI: 10.1038/nature10813

Provided by Okayama University