No Structural Transitions in Solid Fe

Geun Woo Lee[1, S, C], Sangho Jeon[2], Yong Chan Cho[1] and Yun-Hee Lee[1]

[1]*Korea Research Institute of Standards and Science, Daejeon, Korea*
[2]*Deutsches Elektronen-Synchrotron, Hamburg, Germany*
gwlee@kriss.re.kr

Solid iron (Fe) experiences structural transitions and a magnetic transition with temperature; ferromagnetic bcc-Fe (α-Fe) transforms to paramagnetic bcc-Fe at Curie temperature (T_c) of 1043 K, does to fcc-Fe (γ-Fe) at 1185 K, and to bcc-Fe (δ-Fe) at 1667 K again. This behavior of Fe is exotic, since the γ(fcc)-Fe has higher density than α(bcc)-Fe, which cannot be observed with other polymorphic elements. Thus, the origin of fcc-Fe between these bcc phases has attracted significant interest from both fundamental science and practical application viewpoints.

We here report for the first time that δ(bcc)–Fe phase does not transform into γ(fcc)-Fe phase on cooling by using electrostatic levitation, indicating the existence of paramagnetic bcc Fe in the temperature range of γ(fcc)-Fe. Our results support recent simulation studies which shows the comparable Gibbs free energy of bcc and fcc phases in the equilibrium temperature region of γ-Fe. In addition, the gradually increasing specific heat as temperature decreases reflects that local magnetic ordering develops within the temperature range of γ(fcc)-Fe, which is consistent with recent simulation studies.