SHOCK13-2013-000570

Abstract for an Invited Paper
for the SHOCK13 Meeting of
the American Physical Society

Recent Studies in Electrical Transport Properties at Extreme Pressures

TAKAHIRO MATSUOKA, Center for Quantum Science and Technology under Extreme Conditions

High pressure plays important roles in expanding our understanding of materials. Electrical transport properties significantly change as pressure brings atoms and molecules close together. For example, O2, which is insulator at ambient pressure, becomes metallic and even a superconductor under high pressures exceeding 95 GPa [1, 2]. Recently, conductive H2 has been reported at near around 220 GPa and room temperature [3]. On the other hand, Li and Na have been found to become a semiconductor and an insulator in dense conditions that ion core-valence overlap becomes significant [4,5]. The number of elemental superconductors is increasing with the development of high-pressure techniques. Currently 22 of 52 elemental superconductors are known to superconduct only at high pressures. In this talk we discuss very recent experiments that revealed re-entrant metallic and superconducting phase of Li at above 100 GPa. In addition, the simultaneous measurement system of X-ray diffraction, Raman scattering and electrical resistance in BL10XU/SPring-8 is presented. In order to study electrical properties, including superconductivity in detail, and reveal underlying physics, it is very important to observe crystal structures and electrical resistance simultaneously at high pressures. Li becomes a semiconductor at above 80 GPa accompanied with structural transformation [4]. Recently we have observed experimentally that Li reverts to a metal accompanied with oC40→oC24 structural transition at 120 GPa at 50 K. Simultaneous with re-metallization, superconductivity also reemerges with Tc above 10 K. High electrical resistivity value and abrupt appearance of superconductivity may indicate that Li in oC24 is a poor metal with atypical electronic states. The present study found a phase diagram, a semiconductor phase between superconducting phases, not previously observed for any materials.

[1] S. Desgreniers et al., J. Phys. Chem. 94, 1117 (1990).
[2] K. Shimizu et al., 393, 767 (1998).
[3] M. Eremets & I. Troyan, Nature Phys. 10, 927 (2011).
[4] T. Matsuoka & K. Shimizu, Nature 458, 186 (2009).
[5] Y. Ma et al., Nature 458, 182 (2009).