Superconductivity at 250 K in lanthanum hydride under high pressures

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Keywords: high pressure, superconductivity, hydrides.

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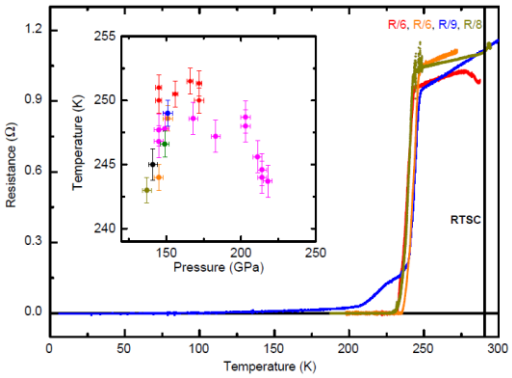
The discovery of superconductivity at 203 K in H_3S [1] returned attention to conventional superconductors whose properties can be described by the Bardeen-Cooper-Schrieffer (BCS) and the Migdal-Eliashberg theories. These theories predict that room temperature superconductivity (RTSC) is possible in metals possessing certain favorable properties, such as lattice vibrations at high frequencies. However, these general theories are insufficient to predict the properties of real superconductors. Such predictions can now be made with the aid of first principles calculations based on Density Functional Theory (DFT). In particular, the DFT-based calculations suggested a new family of hydrides possessing a clathrate-like structure, where the host atom (Ca, Y, La) is at the center of the cage formed by hydrogen atoms [2-4].

These superhydrides can be considered to be doped versions of metallic hydrogen and therefore are expected to have high T_cs. Indeed, DFT predicts a T_c of 235 K at 150 GPa for CaH_6[2], T_c = 305–326 K at 250 GPa[5] (or 303 K at 400 GPa) for YH_{10}, and a T_c ~ 280 K at ~ 200 GPa for LaH_{10}.

In the present work we performed an extensive search for superconductivity in the lanthanum hydrides. The samples were synthesized directly from lanthanum or LaH_3 and hydrogen under high pressure. We have found superconductivity with a record T_c ~ 250 K within the *Fm-3m* structure of LaH_{10} at a pressure P ~ 170 GPa [6]. We demonstrated the existence of superconductivity at 250 K through the observation of zero-resistance, the isotope effect, and the decrease of T_c under an external magnetic field, which suggests an upper critical magnetic field of ~ 136 T at zero temperature. This jump of ~50 K above the previous T_c record of 203 K[1] is encouraging for achieving room temperature superconductivity in the near future.



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