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高温超伝導を目指して

Towards a higher-T_c superconductor

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Superconductivity has been discovered somehow unexpectedly in Hg with a critical temperature of T_c = 4.15 K by Kammerlingh Onnes. Superconductivity is essentially quantum mechanical phenomenon due to a Bose-Einstein condensation. Therefore, much attention has been paid to the superconductivity from the theoretical and experimental points of views. However, its essential weak point is its low T_c. Actually, it has long been believed that the realization of the “room temperature superconductor” is only a science fiction. In the early stage of superconductive material investigations, A15-type superconductors, such as Nb_3Sn, V_3Ga, $Nb_3(Al,Ge)$ and Nb_3Ge, have been found by B.T. Matthias and his collaborators. The superconductors discovered in this stage are called “BCS superconductors” because their behavior can be well explained within the framework of the BCS theory.

However, the discovery of Cu-oxide superconductors in 1986 required a new theoretical interpretation with a new key concept. The important point is that T_c is raised up to 138 K at ambient pressure, which is far above the highest T_c record of 23 K in Nb_3Ge (Fig.1). With the high-T_c record being broken one after another in Cu-oxides, one of the most challenging questions in superconductivity has become “how much will T_c increases in non Cu-oxide superconductors? Within this background, we reported superconductivity at 39 K in MgB2 in 2001, which is the highest T_c among intermetallic superconductors and the T_c is nearly twice compared to previously reported. Although MgB_2 is a well-known popular material, its high T_c superconductivity (T_c =39 K) had been hidden for about 50 years until our discovery. Recently, however, Fe-pnictide superconductor has been discovered by Hosono group, and T_c reached to 55K.

In this situation, the most challenging question is that how much T_c will be increased? I categorize the superconductors into three groups, depending on its T_c: Matsu (T_c > 160 K), Také (160 K > T_c > 77 K) and Umé (T_c < 77 K). No superconductor belongs to Matsu group at present stage, and only Cu-oxide superconductors belong to Také and all other superconductors belong to Umé. Our next target is to find the Také group superconductors, not belonging to Cu-oxide. In this annual meeting, I will talk the past and present status and future prospect of high-T_c superconductivity.

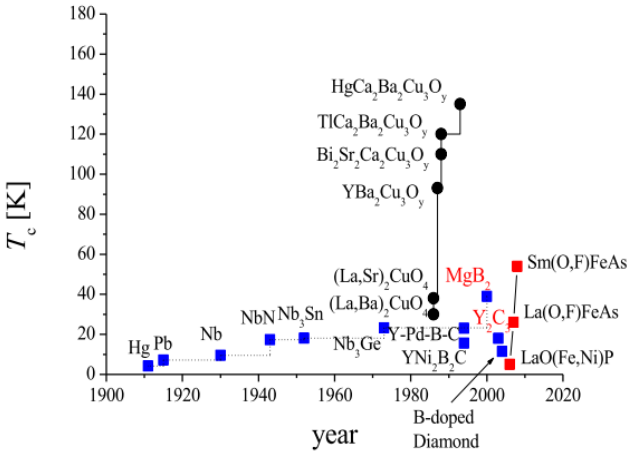

Fig.1: Chronology of T_c