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Invited

High Temperature Superconductors and Its Application

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ABSTRACT

The discovery of high temperature superconductivity in 1986 gave an enormous impact on the solid state physics. The critical temperature reached 125 K in 1988 and it is expected that materials having higher critical temperature may be found in near future. Possible application to information technology, energy technology and medical electronics will be discussed.

Since the discovery of high temperature superconductivity in 1986, the research in this field has been developed explosively. The critical temperature reached 125 K in Tl-based oxide material and higher critical temperature will be observed in some oxide materials in near future. The study of physical properties of these oxide materials has been developed by tremendously many researchers in these one and a half year and it was found that these materials are very peculiar in nature, which solid state physicists have never seen in the long history of solid state physics. This means that it must be necessary to introduce a new concept in solid state physics, which leads to a new theory of high temperature superconductivity.

On the other hand, it becomes clear that these oxide materials have many difficulties, which must be overcome before reaching real applications. It is believed that we must introduce the fruits of modern semiconductor technology in order to solve these difficulties. As to applications, many possibilities are discussed as is shown in the following table, expecially in the field of electronics.

APPLICATIONS

(1) Transportations
- Mag. Lev. Trains
- Electromagnetic Ships
- Spacecraft
- Electric Car

(2) Electricity
- Storage of Electricity
- Transmission Lines
- Superconducting Generator and Motor

(3) Electronics
- Superconducting Wiring in LSI
- One Wafer Computer
- Josephson Devices
- SQUID Devices
  - Infrared Sensor
  - Magnetic Sensor
- Superconducting Transistors
  - MOS Type

Bipolar Type

·MRI

The application of high-Tc superconductors to electronic devices will give rise new attentions. The superconductivity gap in high-Tc superconductors must be quite large compared with conventional low-Tc superconductors. The gap is given by $2\Delta=3.5$ kTc according to an accepted phenomenological theory. Even though the exact values of the gap in high-Tc superconductors have not been determined yet, it seems that real 2Δ is larger than 3.5 kTc. Therefore, if we obtain critical temperature of 300 K, the gap 2Δ may reach 0.1 eV. This value is nearly the same as the band gap of InSb.

Thus, it is hoped that the hybridized devices composed of semiconductors and superconductors may be of great interest in near future. These devices must have high speed and very small power consumption like Josephson devices.