Aiming at a Breakthrough

Present Views and Future Prospects of Superconductivity Science and Technology

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This year represents a turning point for research in superconductivity. The year 2011, just four years away, will mark the 100th Anniversary of the discovery of superconductive phenomena, and this year is the 20th year since the discovery of oxide high-temperature superconductors with critical temperatures that exceed the temperature of liquid nitrogen. The Superconductor Division was established following the discovery of these high-temperature superconductors. In the midst of a "superconductor boom," a great deal of information was coming out in the media, and at times it was difficult to determine which information was true and which was not. In that backdrop, the mission of the Superconductor Division was to carefully select correct and meaningful information and provide valuable services to members, thereby supporting the effective undertaking of individual research activities. Even now that the Superconductor boom is over, that original intent has not changed. With the passage of time, however, the directions in research have expanded to include technologies in this fascinating area of science that will be of use in people's daily lives. Because of the presence of limiting conditions that differ from "pure sciences," such as the economy and the environment, the proliferation of superconductor technologies requires discussions from a broader perspective. The Superconductor Division is currently planning research meetings that will provide cutting-edge themes, including competitive technologies and peripheral technologies, so that members can examine a broader scope of application fields, and conduct discussions from a variety of perspectives. At the same time, with an awareness that developing new manpower is also part of its mission, it actively provides support to young researchers, for example by publishing texts loaded with new information, and holding schools that offer detailed, easy-to-understand explanations of superconductivity from the fundamentals to practical applications.

Superconductor applications are divided into four main categories: Energy and the Environment, including power storage; Industry and Transportation, including magnetic levitated trains; Diagnostics and Medicine, including neuro-magnetic measurements; and Information and Communications, including super-high-speed computers. At the regular lectures in the Spring and Fall JSAP Meetings, there are a total of about 200 lectures focusing on not only fundamental characteristics, but also crystal growth technologies, process technologies, elemental circuit technologies, system element technologies, and material technologies that support superconductor applications. Superconductive phenomena still maintain a degree of mystery in some respects, as demonstrated by Prof. Akimitsu's discovery of MgB_2 superconductors in 2001, and dramatic developments in superconductive quantum bits. The "New Materials / New Devices" category was created in the Superconductivity Section as a venue for presenting this kind of new information as quickly as possible. The core of the Superconductor Division's activities is the symposiums and internal lecture meetings held during the semi-annual research meetings and JSAP meetings. At these events, members expand the framework of presentations made at the regular lectures based on the intent of the Superconductor Division, and provide support for the further development of members' research by creating plans that cover all aspects of superconductors, from fundamental characteristics to the applications noted above.

Research in superconductivity differs from other research in that cooling is required. I think that researchers and managers have more of a resistance to cooling than regular individuals. They have a vague image of cooling as being expensive and unreliable, but this image acts as an impediment to research in superconductivity, and makes people reluctant to introduce superconductive technologies. It goes without saying that freezing technologies are highly reliable – this has been demonstrated in a variety of applications; for example, in the case of cryopumps. Furthermore, as long as heat inflow is minimized, almost no cost is required to maintain low temperatures. In fact, a number of superconductive technologies have already been implemented in practical applications. Magnetic Resonance Imaging (MRI), for example, which has been adopted in many hospitals recently, uses superconductive electromagnets. Superconductive tunnel junctions have been used for some time in the sensors that play an important role in radio astronomy. Recently, Superconducting Magnetic Energy Storage, (SMES) and superconductive band-pass filters have virtually entered the practical application stage. If we can help the general public to understand the current situation, then it will be possible to eliminate the negative image of superconductive technologies. As superconductive technologies and other related technologies are incorporated into more and more practical applications, we believe that the Superconductor Division will be required to play an increasing role in accurately communicating the current and future potential of these technologies. This goal was already achieved at a Lecture Meeting held in conjunction with the 54th JSAP Meeting in the Spring of 2007, at a special exhibit focusing on the theme of "The Cutting Edge of Research and Development in High-temperature Conductors." This exhibit included actual displays of next-generation wire coils using YBa_2Cu_3O; high-frequency waveform measurement systems using high-temperature superconductive single flux quantum circuit technologies; high-temperature superconductive band-pass filters; and high-temperature superconductive high-sensitivity magnetometers. Video presentations offered an introduction to high-temperature superconductive motors and large-scale bulk targeting outer space applications, as well as ultra high-speed routers that use Nb integrated circuits – one example of low-temperature superconductors currently approaching the practical application phase.

As outlined above, we will meet expectations by expanding the Superconductor Division to cover an even broader range of application fields, and bringing together researchers who tend to be confined to specialized application fields by establishing themes that provide an opportunity for new interactions, both vertical and horizontal. We will provide a venue for exchanges of information among superconductivity researchers, and with researchers in related technology fields. We are also aware of the importance of manpower training and education as a core aspect of the Division's activities in the future. JSAP