Concerning the corrosion problem in MgB_2/Al composite material

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During one month of my staying (2-31st July 2007) in Professor Ikeno laboratory, I had some interesting discussions about light metals including superconducting aluminum materials. These discussions were concerned the research and development of light materials that having nano-scaled structure and analysis of their structure.

I started research collaboration with Prof. S. Ikeno and his colleague, concerning the corrosion problem in their research, about MgB_2/Al composite material. This superconductive "MgB_2/Al" composite material with low and high volume fraction of particles is fabricated by pre-packing technique and 3-dimentional penetration casting 3DPC method. The critical temperature of superconducting transition (Tc) was about 37-39K. In addition we discussed about the application of magneto-optical imaging (MOI) in order to understand more about superconducting properties. We also started research about synthesis and properties of bulk magnesium diboride (MgB_2) samples obtained by self-propagating high-temperature synthesis (SHS) to obtain good MgB_2 bulk sample. The magnetic field and the temperature dependencies of the dispersive and absorption ac magnetic susceptibility as well as resistivity of the MgB_2 specimen made by SHS technique have been measured and analyzed. The superconducting transition was very sharp and very sensitive to the ac and dc magnetic fields. The critical current density was extracted from the absorption susceptibility via a superconducting critical state model. MgB_2 plates were dense, without cracks, and contained very small uniformly distributed MgO particles, ranging from 10 to 70 nm. The samples for magneto-optical imaging (MOI) were 6 mm × 18 mm in size with different thickness of 650 μm and 230 μm. The superconductivity in the sample vanished at 35.0±0.2 K. Some particles on the surface of the bulk material actually had better properties than the surrounding. This was visible only 1-2 K below TC. The particles showed up both with extraordinary good shielding properties (field up), and extraordinary good pinning property (removal of applied field). With MOI using fraction of penetrated area to determine Jc, it was found that at 30 K and, JC is 43 kA/cm^2. We found a nearly linear dependence of $J_C(T)$ in self-field reaching $8 \cdot 10^9$ A/m^2 at 0 K. It was concluded that MgB_2 is a hard II type superconductor and that SHS method is suitable to fabricate material with strong pinning centers of MgO. From the beginning of the Mg-B system investigations, pressure was an important factor in procedures obtaining the bulk superconductors for application purposes: at hot isostatic pressing (HIP-ing), annealing under inert or active gas medium, i.e. argon with hydrogen and nitrogen, or for extrusion methods for wires manufacturing. MgB_2 reveals interesting properties. We presented the current state of our technological efforts in improving the microstructure and superconducting properties of this material, with use of the high gas pressure and high temperature treatment of samples crystallized in crucibles made of BN and SiC. As the precursor we mainly used the commercial MgB_2 powder, the critical temperature of HIP-ed samples doped by SiC was the highest one (42.6 K). The results of microstructure investigations and XRD analyses are presented. This MgB_2 would be useful to improve Tc and Jc.

I also had a presentation for VBL special lecture entitled as: Interconnector materials for the planar solid oxide fuel cell (SOFC) applications on July 18th 2007.

We also had fruitful discussion for the following research projects for the future collaboration:

1- Relationship between tensile deformation and crystallographic orientation of grains in the balanced

Al-Mg_2Si alloys.

2- HRTEM studies of β-α phase transformation in Cu-Zn alloy annealed at lower temperature.

3- The effect of additional elements on precipitation sequence in high strength Al-Mg-Si alloy system.

4- The effect of additional elements on strengthening in Al-Mg-Si alloys.

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