Prototype Fe-based Superconducting Wire Using Fe(Se,Te)

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Materials which show zero electrical resistance at low temperatures are called superconductors. In the superconducting state, it is possible to transmit electrical energy over great distances with no loss. If it were possible to circle the planet with wire manufactured from a superconductor, generating solar power on the sunny side of the globe during daytime and transmitting it to areas on the nighttime side would not be a dream.

Recently, Fe-based superconductors have been a topic of great interest as a new type of high temperature superconductor. Our groups has been working to develop wire materials using these Fe-based superconductors. The test material used in this research is a Fe(Se,Te) material, which has the simplest crystallographic structure among the Fe-based superconductors and has a superconducting transition temperature (Tc) of approximately 14K. Because iron, which is its main component, is an element which exists on Earth in great abundance, we devised a unique superconducting wire manufacturing method in which Fe is used as the sheath material (material forming the outer shape of the wire) and, at the same time, also serves as a raw material for the Fe-based superconducting substance which is formed in the interior.

Fig.1 shows a schematic diagram of the wire material manufacturing process. First, an SeTe compound is prepared by reacting Se and Te in advance. These are the non-Fe components of the Fe-based superconductor. This SeTe compound is then filled into an iron pipe, which will form the sheath material. The filled pipe is then rolled into a long, thin, tape-shaped wire material with a width of 4.3mm and thickness of 0.55mm using grooved rolls and flat rolls. The wire material obtained in this manner is sealed in a quartz glass tube so as to prevent reaction with the air, and heat treatment is performed. When this was done, the SeTe compound in the tube reacts with the Fe sheath, and a Fe(Se,Te) superconductor is synthesized inside the sheath. A scanning electron microscope image of the cross section of the obtained wire material is shown in **Fig.2**. A satisfactory filling condition, in which the superconductor was in close contact with the sheath, with no crevices or spaces, was obtained on both sides of the wire material.

Electrodes were attached to the wire material and a current test was performed. As a result, a superconducting current was successfully passed through a wire material using an Fe-based superconductor for the first time in the world. Although the critical current density still shows a small value of J_c=12.4A/cm^2, various efforts to achieve higher values are planned, including increasing the filling rate and improving the bonding between the sheath and the superconductor, use of a multicore design, introduction of flux pinnig, etc. This is expected to result in further improvement in the superconducting critical current value in the future.

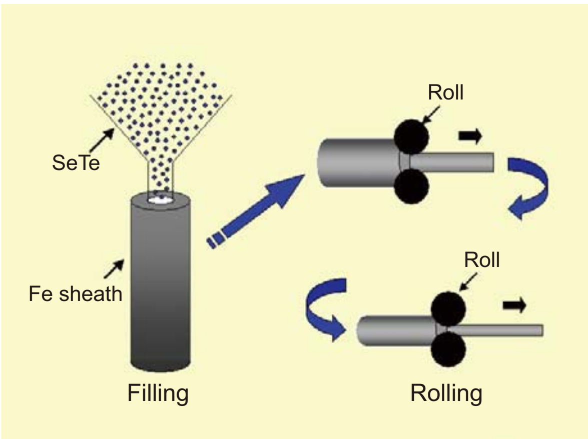

Fig.1 Schematic diagram of the wire manufacturing process.

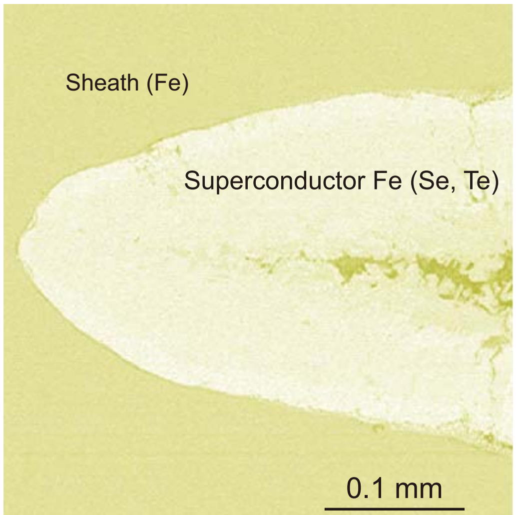

Fig.2 Scanning electron microscope image of cross section of superconducting wire.