Meissner Effect Encyclopedia Article

Meissner Effect

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Meissner Effect

In 1933, two German physicists, Walther Meissner and Robert Ochsenfeld, were studying superconductivity (the tendency of a substance to lose all resistance to the flow of an electrical current) in tin. They discovered that at 3.72 Kelvin (3.72 degrees above absolute zero or -276.87°C), a cylindrical rod of tin exhibited an unusual and unexpected property: it expelled the Earth's magnetic field from its interior and became perfectly diamagnetic. Later research showed that this behavior is characteristic of all materials as they approach the superconducting phase. It has since become known as the Meissner effect or, less commonly, as the Meissner-Ochsenfeld effect. In fact, the magnetic field is not totally expelled in the Meissner effect, but resides in a very thin layer less than a millionth of a centimeter thick on the outside of the superconducting material.

A significant discovery has been that the presence of a strong external magnetic field can counteract the Meissner effect. When such a field is applied to the material, transition to the superconducting state does not occur. This discovery has had a profound effect on the development of practical applications for superconductors. One of the most valuable of these applications would be in the production of magnets, but the tendency of an external field to inhibit the transition to superconductivity presents difficult practical problems in the development of this application.

The nature of the Meissner effect is dependent upon the type of material used, its purity, shape, and size. So-called Type II superconductors, such as niobium and vanadium, never exhibit more than a partial Meissner effect, no matter how they are fabricated. The Meissner effect has been of theoretical importance in understanding the flow of electrons in a superconductor and, therefore, in the development of superconductor theory.