Superconductors

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Superconductors, materials that have no resistance to the flow of electricity, are one of the last great frontiers of scientific discovery.

A Superconductor is a material that will conduct electricity without resistance below a certain temperature. Once set in motion electrical current will flow forever in a closed loop of superconducting material making it the closest thing to perpetual motion in nature. Scientists refer to superconductivity as a macroscopic quantum phenomenon.

In 1911 superconductivity was first observed in mercury by Dutch physicist Heike Kamerlingh Onnes of the Leiden University. When he cooled it to the temperature of liquid helium, 4 degrees Kelvin (-269C), its resistance suddenly disappeared. Later, in 1913, he won a Nobel Prize in physics for his research in this area.

In 1933 German researchers Walther Meissner and Robert Ochsenfeld discovered that a superconducting material would repel magnetic field. This phenomenon is known as strong diamagnetism and is today often referred to as the "Meissner effect". It is so strong that a magnet can actually be levitated over a superconductive material [1].

The first widely-accepted theoretical understanding of superconductivity was advanced in 1957 by American physicists John Bardeen, Leon Cooper, and John Schrieffer. Their Theories of Superconductivity became know as the Bardeen-Cooper Superconductivity.

Magnetic-levitation is an application where superconductors perform extremely well. Transport vehicles such as trains can be made to "float" on strong superconducting magnets, virtually eliminating friction between the train and its tracks.

An area where superconductors can perform a life-saving function is in the field of bio-magnetism. Magnetic Resonance Imaging (MRI) was actually discovered in the mid 1940's. But, the first MRI exam on a human being was not performed until July 3, 1977.

Electric generators made with superconducting wire are far more efficient than conventional generators with copper wire. In fact, their efficiency is above 99% and their size about half that of conventional generators [2].

An idealized application for superconductors is to employ them in the transmission of commercial power to cities.

Superconducting magnets are some of the most powerful electromagnets known today. They are used in MRI and NMR machines and the beam-steering magnets used in particle accelerators.

Superconductors are used to build Josephson junctions which are the building blocks of SQUIDs (superconducting quantum interference devices), the most sensitive magnetometers known [3].

Promising future applications include high-performance smart grid, electric power transmission, transformers, power storage devices, electric motors, magnetic levitation devices, fault current limiters.

Bibliography:

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