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NASA TECH BRIEF

Niobium Thin Films Are Superconductive in Strong Magnetic Fields at Low Temperatures

The problem:

To develop a superconductor capable of carrying high current in strong magnetic fields. Materials that are capable of carrying high currents when supercooled characteristically lose their superconducting properties when subjected to a strong magnetic field.

The solution:

A very thin film of niobium formed on an inert substrate through evaporation in a vacuum environment. Control of temperature and vacuum results in rejection of gaseous impurities so that the niobium film is of very high purity.

How it's done:

Niobium in granular form is placed in a chamber and the chamber evacuated to a pressure of about 10^{-8} mm Hg. A self-accelerated electron beam gun melts the niobium and raises the temperature of the molten metal to 3100–3250°C. The substrate to be coated is heated and protected from the niobium vapor by a shutter. The shutter is moved aside as the substrate temperature reaches 200°C and the substrate is briefly exposed to the stream of niobium vapors. This procedure is repeated until the desired film thickness has been reached.

The high power input to the niobium causes it to give off a vapor stream with a pressure of 0.1 mm Hg. Possibility of a contaminant to penetrate this vapor stream is limited by the vapor pressure so long as it is maintained greater than the chamber pressure.

Notes:

1. In tests of experimental films at liquid helium temperature and in a transverse perpendicular magnetic field of 12,000 oersteds, the following results were obtained: a 300Å film carried 4 milliamperes; a 1000Å film carried 50 milliamperes; and a 5000Å film carried 300 milliamperes.
2. This method permits the use of a relatively high chamber pressure to produce a coating purity that previously required chamber pressures on the order of 10^{-10} mm Hg absolute.

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act (42 U.S.C, 2457(f)), to National Research Corporation, 70 Memorial Drive, Cambridge, Massachusetts, 12142.

Source: Peter Fowler and Phillip J. Clough
of National Research Corporation
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Category 02