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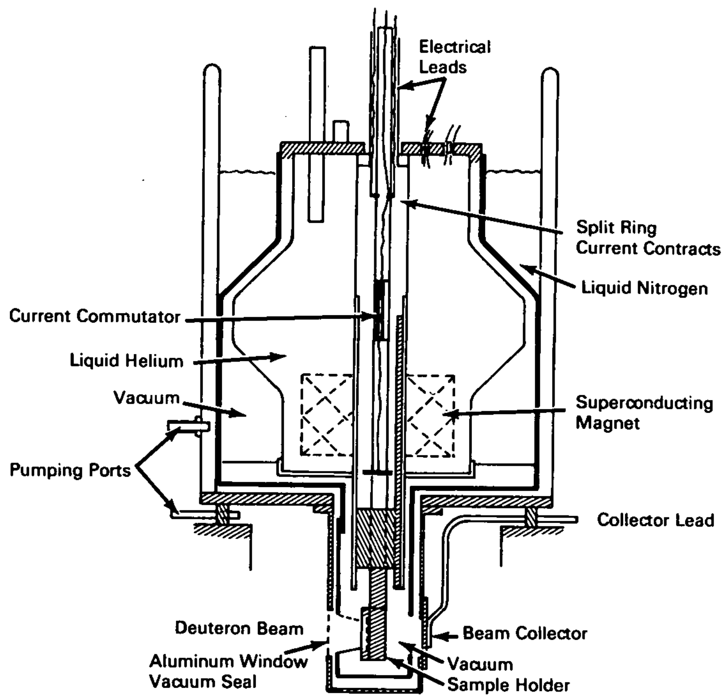
NASA TECH BRIEF

Mechanisms of Superconductivity Investigated by Nuclear Radiation



IRRADIATION CRYOSTAT AND SAMPLE CONFIGURATION

The advent of high field superconducting magnets in the past few years has led to many suggestions for their use in diverse applications and in a variety of environments. Among the many scientific and technological advances made during this same period is the ability to place instruments and men in space for long periods of time. Because nuclear radiation is ever present in space and can at times be quite intense, it is of prime importance that some means be provided for shielding space vehicles from this radiation. One method of accomplishing this is by surrounding the vehicle with a superconducting magnet which produces a magnetic field strong enough to deflect incident charged particles from the vehicle. Other uses of superconducting magnets which will expose them to radiation environments are in bubble chambers, magnetohydrodynamic (MHD) power generation devices, and nuclear particle accelerators. It is necessary, then, to know the behavior of the superconducting magnet and its constituent materials during and after exposure to various types of radiation.

An investigation of some of these phenomena was

(continued overleaf)

undertaken and a description of the research and a discussion of the effects that these might have on the performance of such magnets are contained in a technical report: "Investigation of the Mechanisms of Superconductivity by Nuclear Radiation," by E. L. Keller, H. T. Coffey, A. Patterson, and S. H. Autler, Westinghouse Research Laboratories, December 14, 1965.

Low temperature radiation effects in type-II superconductors were studied using 15 MeV deuterons. Properties measured were critical current density j_c, transition temperature T_c, upper critical field H_{c2}, and resistivity ρ. Materials studied were Nb–61%Ti, Nb–25%Zr, Nb_3Sn, Nb, and Pb. The samples were irradiated at about 30°K in a cryostat.

The following are some of the test results: Resistivity was generally increased during irradiation and T_c decreased. Changes in H_{c2} (generally reductions) are correlated with the changes in T_c and ρ. Reductions of about 20% in j_c of cold worked NbTi and NbZr were observed whereas the only j_c effect in strain-free NbZr was the production of a peak effect near H_{c2}. Large j_c changes were found in Nb_3Sn, an increase in low j_c material and a decrease in high j_c material. The induced effects in the alloys and pure metals were reduced by 75% or more in warming the samples to room temperature. In Nb_3Sn less than 25% of the induced effects were recovered by annealing at 300°K.

Note:

Copies of the report are available from:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B67-10057

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: E. L. Keller, H. T. Coffey,
A. Patterson, and S. H. Autler
(M-FS-1944)