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ENERGY STORAGE IN METAL DEVICES AND THE ADVANTAGES OF LIQUID HYDROGEN TEMPERATURES

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Low temperature charge transport in pure polycrystalline aluminum is investigated under strong hall drift by means of cylinder conductor study in coaxial external magnetic field, a current being made to flow between inner and outer concentric contacts. Azimuthal carriers motion and connected with that stimulated self magnetic field is investigated in wide range of radial current density up to 3000 A/cm^2, external magnetic field up to 8 T in the temperature range from liquid helium to hydrogen. The different forms of studied conductors are regarded with the aim of choise of the most optimal geometry of cylinder conductor.

Electron scattering processes are investigated in an absence of hall electric field and it is shown that at low temperature the relaxation electron mechanisms are beyond of dirty limit approximation. At cryogenic temperature a relaxation time is modified by strong temperature dependence of resistivity on the reason of high succeptibility of resistivity to anisotropy of dispersion law and phonon scattering. High level of self magnetism in cylinder conductors made from aluminum being an uncompensated metal is known to be due to condition of strong magnetic field when larmor frequency is much higher of reversal relaxation time. In this connection the rule of thermal phonons in current flow through an effective average conductivity tensor of polycrystalline medium is investigated by means of intra-crystalline and orientational averaging of kinetic processes taking into account the existence of both closed and elongated electron orbits. The effective relaxation time is investigated both experimentally and analytically for a correlation of self magnetic field value to be established. Free electron approximation of kinetic processes is compaired with experimental data and it is indicated that the real relaxation time decreases in presence of anisotropy of electron scattering on phonons. Decrease of parameter of effective magnetic field leads to decrease of self magnetic field stimulated by spiral motion of carriers.

Self magnetic field is parallel to external that when current flows from outer contact to inner beyond of direction of external that. In other case these fields are antiparallel. It is established that energy density of self field in sample volume may achieve of the order of energy density of traditional inductive energy storage at liquid helium temperature. Self energy density of 1 J/cm^3 has been realized in experiment on disk shaped samples having inner and outer contacts 3 and 30 mm respectively and thickness of 2 mm. The residual resistance ratio of sample was of the order 15000. Magnetic field distribution on the sample surface having been calculated by means of averaging of scattering processes correlates with experimentally obtained data received by extraction of external field from total that measured on the sample surface. High succeptibility of relaxation processes to temperature leads that at liquid hydrogen range a parameter of magnetic field efficiency is a third of that at 4.2 K and averaged self magnetic energy achieves of magnitude of 0.1 J/cm^3.

High levels of energy accumulation in such cylinder conductors may be applied for development of different cryogenic technique functioning on the principle of magnetic energy storage with both high and weak magnetization. In this case the energy of self magnetic field parametrically depends on external magnetic field magnitude, value of current and its direction, temperature. Cylinder conductor having a spiral current carrier motion between inner and outer contacts in external magnetic field may be represented as an inductor element. This element has own inductive and resistive parameters determined by the time of own transient processes. The characteristic transient time of experimental conductor has been calculated and is represented as a function of current and external magnetic field. In the case of our experiment the characteristic time being of the order of 1 sec has a weak dependence of current magnitude.

These principles may be based to enhance the magnitude of accumulated energy of superconductive and others energy storages by placing in it of aluminum based cylinder core having a radial current. Such cylinder conductor may act as an independent energy accumulator if it situated in any external magnetic field. Besides a high level of magnetoresistivity and self magnetic energy depending on current direction may be used for quasi steady current rectification when the regime of voltage supply takes place. Such resistivity - inductance elements may find an application in devices of control for cryogenic powerful magnetic system.