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EFFECT OF CARBON COATING ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF THIN CARBON-DOPED MOLYBDENUM

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We investigated carbon-doped molybdenum films obtained by cathode sputtering at a Kr pressure of 10^{-5} Torr.

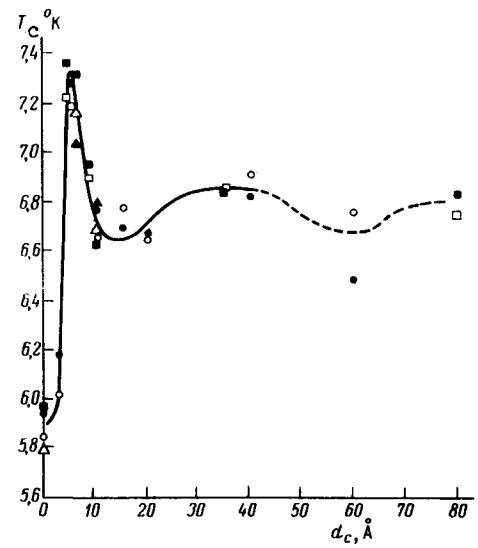
The apparatus described in [1] was improved to permit production of several samples in a single sputtering experiment and to deposit on them coatings of different thicknesses. Coatings of equal thickness were sputtered simultaneously on two samples that differed only in the film width (w_1 = 3 mm and w_2 = 6 mm). This made it possible to estimate the influence of the film edges and of random contaminations of the substrates. The partial pressure of all the residual gases, with the exception of hydrogen, was not higher than 10^{-10} Torr, and the partial pressure of hydrogen was 2×10^{-9} Torr.

To prepare the samples we used mosaic Mo-C cathodes and their geometry was such that samples with carbon concentration of 20 at.% were obtained. All samples were 60 Å thick.

The thicknesses of the superconducting film and of the coating were determined from the sputtering times. The rate of deposition of the coating, measured in special experiments, was 2 Å/min and made it possible to set the coating thickness with sufficiently high accuracy. T_c was taken to be the temperature at which the film resistance assumed the value $R = R_n/2$, where R_n is the resistance in the normal state.

The dependence of the critical temperature of the samples on the coating thickness is shown in the figure.

A considerable growth of T_c was observed at all coating thicknesses. For samples with coating 4 - 6 Å, the critical temperature rose 1.4°K (24%) and T_c of samples with 80-Å carbon coating rose 0.9°K (15%) compared with the film without the coating. The curve was characterized by a sharp maximum of T_c at 5 Å, a gently sloping minimum



Dependence of critical temperature T_c on the carbon film thickness d_c. The points designated by different symbols correspond to samples obtained at different sputterings. The dark and light symbols pertain to films with different widths.

at 15 Å, and a gently sloping maximum at 40 Å. No definite statements can be made concerning the behavior of the curve at large thicknesses, owing to the small number of points in this region. It is possible that the curve remains oscillatory at these thicknesses. In our experiments we observed a definite correlation between the critical temperatures of the samples and their resistivities in the normal state.

The influence of the coating on T_c of thin films was investigated by many authors [2 - 5]. As a rule, a small ($\sim$0.1°K) rise or fall in the critical temperature, practically independent of the coating thickness, was observed. The change of T_c was attributed in these papers to a decrease in the electron concentration, owing to the escape of electrons into the barrier layer and formation of the contact potential difference between the film and the coating.

Naugle [5], in a study of the influence of germanium coating on the critical temperature of thallium films, obtained a dependence on the coating thickness with a maximum at a Ge layer thickness of 10 Å. The rise in the critical temperature at the maximum was only 0.1°K.

Neither the oscillating $T_c = f(d_c)$ curve which we obtained, with a very narrow first maximum having an appreciable amplitude ($\Delta T_c = 1.4$°K) nor the nonmonotonic $T_c = f(d_{Ge})$ curve observed in [5] can be attributed to a contact potential difference at the boundary between the metallic film and the coating. It can be assumed that in all probability an important role is played here by changes occurring in the electron or phonon spectrum of the system comprising the metallic film and the coating when the coating thickness amounts to several monatomic layers.

In conclusion, the authors are grateful to B.N. Samoilov and N.A. Chernoplekov for constant interest in the work.

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NUCLEAR ECHO IN THE TRANSPARENT ANTIFERROMAGNET FeF_3

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Iron trifluoride FeF_3 is an antiferromagnet that has a weak ferromagnetic moment [1, 2]. The crystal belongs to the space group $R\bar{3}C$, the elementary chemical cell contains two molecular units, and the chemical and magnetic cells coincide [3]. The iron ions are in several distorted octahedra made up of the fluorine ions. The Neel temperature lies near 362 - 363°K [4, 5]. FeF_3 single crystals are transparent in the visible part of the spectrum [6].

We present here the first report of an investigation of nuclear magnetic resonance in FeF_3. The sample was an assembly of small ($\sim$0.1 mm) single