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ON THE POSSIBILITY OF USING LITHIUM-6 DEUTERIDE, IRRADIATED WITH GAS DISCHARGE PLASMA IN A TARGET WITH POLARIZED NUCLEI OF DEUTERIUM AND LITHIUM

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^6LiD is several orders higher than that of a pentavalent chromium complex compound in fully deuterated propanediol, which is used in polarised deuteron targets at JINR-IHEP (Serpukhov) and LINP (Leningrad) |6,7|.

Experimental

The deuteride that was at our disposal has the following characteristics. It was a grey-blue crystalline substance ringed with violet. According to the certificate, the mass percentage of the basic substance was 98% with the degree of deuteration 99 atomic per cent, the atomic percentage of the lithium-6 isotope was 90.7%.

The sample to be investigated was prepared in the following way. Several milligrams of ^6LiD were introduced in a quarts glass ampoule 2 mm in diameter. This procedure took place in closed box filled with helium. Then the ampoule was evacuated and soldered. The EPR spectra were recorded by the Varian E-12 spectrometer. Concentrations of paramagnetic centres were estimated by comparing $h(H)^2$ parameters of the sample under investigation and of the reference one.

In this sample we registered an EPR signal at the nitrogen and room temperature. At T=77 K the signal is a single symmetric line with $H = 0.5\cdot 10^{-4}$ T, its intensity being independent of the temperature. In our opinion, this fact may indicate that there are conductance electrons of metallic lithium in the sample. Li concentration in the deuteride can be approximately estimated as $1\cdot 10^{16}$ paramagnetic centres in a cm^3 (p.c./cm^3).

Thus, ^6LiD has original metallic lithium impurity, probably in the form of colloid particles. Yet, in its mass percentage of the basic substance our reagent complied with the certified characteristics.

The aim of our work was to find out if it is possible to use ultraviolet (UV) irradiation and gas discharge for generation of F-centres in ^6LiD.

A 1-hour exposure of a ^6LiD sample, prepared in the above way, to UV radiation results both in an EPR signal from Li with $H = 0.5\cdot 10^{-4}$ T and in a wide signal with $H = 9\cdot 10^{-4}$ T (Fig. 1). The wide signal is easily saturated as the microwave power increases. The signal also disappears when the sample is heated to room temperature. The intensity of the narrow signal increases with the irradiation time while the intensity of the wide one reaches its limit quickly. The concentration ratio of F-centres to conductance electrons, estimated by the data of Fig. 1, shows that the number of F-centres produced is about twice as high as the original number of conductance electrons.

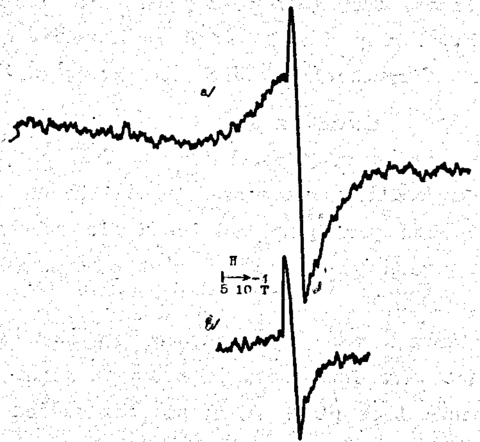

Fig. 1. EPR spectra of ^{6}LiD crystals irradiated with UV at 77 K.
a) after 1-hour irradiation;
b) after heating the irradiated sample to room temperature.

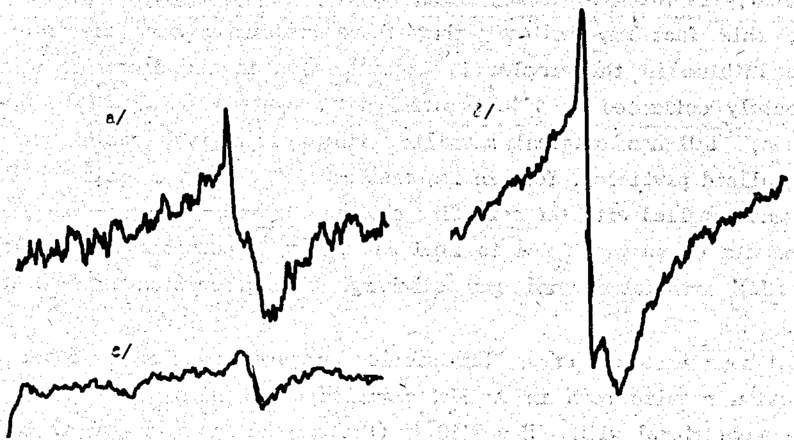

Fig. 2. EPR spectra of ^{6}LiD crystals at 77 K after their exposure to the gas discharge plasma at 143 K.
a) 1 hour; b) 4 hours; c) signal from detects of the Dewar flask quartz.

Being not satisfied with this ratio, we tried to produce F-centres by a gas discharge. The ampoules with ^{6}LiD, evacuated to 10^{-2} mm Hg, were connected to the electrode of a spark leak detector (model IO 60.010). An ampoule was fixed to a float in a Deraw with liquid nitrogen enough to be in the temperature region T = 145 K. Fig. 2 shows EPR spectra for a 1-hour and 4-hour exposure of ^{6}LiD crystals to gas discharge. As follows from Fig. 2, there is a noticeable increase in the concentration of F-centres as the exposure increases from one to four hours. The spectra recorded are a little distorted by a signal from defects in the Dewar flask quartz resulted from UV experiments.

Thus, it is shown that one can in principle obtain F-centres, and we hope that advance in the production technique (change of temperature, thorough selection of crystals, longer exposure to gas discharge) will allow considerably higher concentrations and quantitative estimation of paramagnetic centres in ^{6}LiD.

Finally, we should like to point out that analysis of the works devoted to the study of nuclear polarisation in electron-irradiated ^{6}LiD allows a conclusion that magnetic fields of $H \geq 5$ T are required for higher polarisation |1,3,4|. The recent investigations of deuteron polarisation in deuterated alcohols (propanediol and butanol) at 2.5, 3.5 and 5 T |8| and irradiated ammonia at 5 T |9| showed that higher magnetic fields require substances with concentrations of paramagnetic centres much less than $6 \cdot 10^{19}$ p.c./cm^3. Our preliminary experiments showed that it is possible to obtain the suitable samples by exposing ^{6}LiD to the gas discharge plasma.

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