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Study of composed of insertion graphite hydride of sodium by electronic paramagnetic resonance (EPR)

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From the electronic point of view, graphite is a semi metal, the density of the charge carriers is approximately 10^{-4} by carbon atom. Insertion in the graphite of made up donors of electrons, is accompanied by a strong increase in conductivity in the plan and along the axis c. Reaction of the sodium hydride with the graphite led to the formation of ternary hydrogenated compounds of different stages. The electronic paramagnetic resonance applied to these compounds indicates the conducting character of these species.

Key words: graphite, hydride of sodium, composed of insertion, electronic, standard paramagnetic resonance dysonien, width with middle height.

I-INTRODUCTION

Thanks to the low intensity of the forces which bind between them the graphitic layers and to the great cohesion of the carbon atoms in the plan, graphite can accomodate various substances between its layers to form compounds of insertion. The bodies that one can insert can be either of the species acceptors of electrons, or of the species donors of electrons. The sodium hydride belongs to this last case, it gives with the graphite of made up of insertion belonging at several stages [1]. The study of these compounds by electronic paramagnetic resonance makes it possible to confirm the conducting character of these species.

II- SYNTHESIS AND CHARACTERISATION

The sodium hydride reacts directly with graphite, in a tube out of vacuum sealed glass, to give ternary compounds belonging at the stages one to eleven.The temperature of reaction lies between 400 and 500°C and the duration of reaction varies few hours at one week.
The chemical composition varies from $NaHC_{2,65s}$ with $NaHC_{4,69s}$ (s = stage = the number of plans of graphite which separates two successive layers of insérats) [2]. The reactional mechanism of the insertion of the sodium hydride in graphite occurs in only one stage: the hydride fits to form the ternary one directly in which the H/Na report/ratio is close to one, contrary to the insertion of the potassium hydride which is done in two stages. The study with x-rays of the reflexions 00l of these ternary compounds (Figure 1) makes it possible to identify the product: one determines starting from the diffractograms the period of identity I_c which represents the distance separating two successive layers inserted as well as the distance interplanaire di = 7,3 Å into 7.6 Å [3].

This study made it possible to also show an organization according to the axis c in tricouche between the graphitic layers C-Na-H-Na-C.

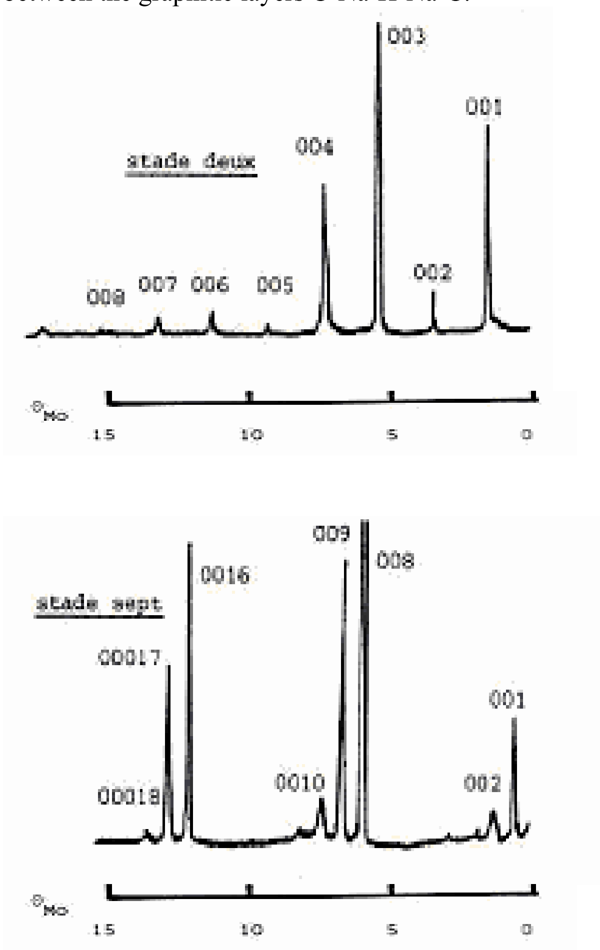

FIG. 1: Reflexions 00l of the ternary compounds G-NaH of stage 2 and stage 7

The plane structure of the layers is rectangular and commensurable with that of graphite. The study of the reflexions hkl shows that there is a three-dimensional order and that the parameter c is equal to the double of the period of identity. The study with x-rays made it possible to highlight the presence of sodium hydride in inclusion in these ternary compounds

III- STUDY OF COMPOSE OF INSERTON GRAPHITE HYDRIDE OF SODIUM BY ELECTRONIC PARAMAGNETIQUE RESONANCE (EPR)

Electronic paramagnetic resonance (EPR) is based on the interaction of not paired electrons of the paramagnetic substances with a high frequency electromagnetic field of H_1 amplitude in the presence of a magnetic field static H_o says directing field. The study was carried out, in Orleans with the C.R.S.O.C.I., on ternary compounds graphite hydride of sodium of stage one to seven. For the weak stages (until stage 4), the shape of the lines is fine and simple, of dysonien type characteristic of a driver (Fig 2).

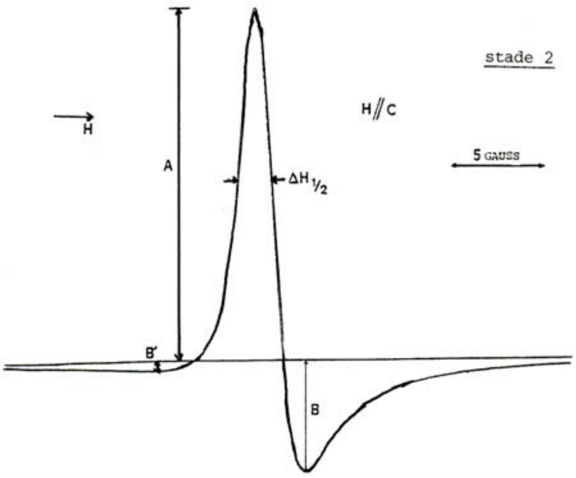

FIG. 2: Stripe EPR of made up G-NaH of stage 2

the width with middle height $\Delta H_{1/2}$ is minimal at the stage two [4], which is the general case in the compounds with the donors of electrons. The B' amplitude of the negative peak in low magnetic field is, in general, lower than B For the stages higher than four, the shape of the lines is abnormal: there is B' >B (Figure 3). This effect is observed if there is an inhomogenous sample, this explanation is probable if the results of the structural study are looked at which highlight the presence of sodium hydride (insulator) included between the conducting layers of graphite.

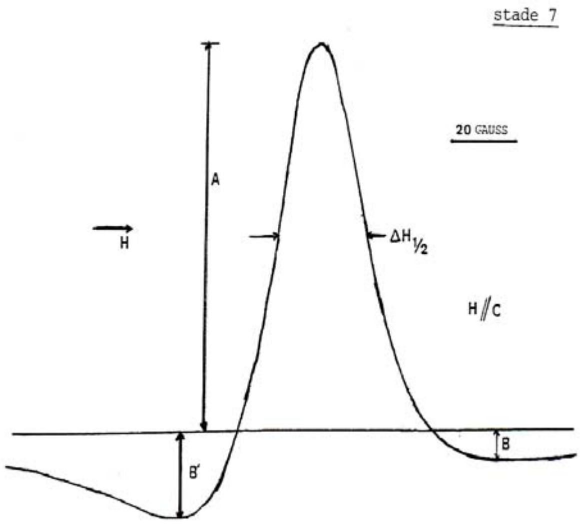

FIG. 3: Stripe EPR of made up G-NaH of stage 7

The width with middle height of line EPR is related to the processes of paramagnetic relieving, it is determined by the lifespan of the electron not paired on a certain energy level. The lower the width with middle height is, the more the mobility of the charge carriers is significant. The comparison of the values of $\Delta H_{1/2}$ for the various stages shows that this one increases when the stage rises i.e. more the compound is poor plus the relaxation times t_1 and t_2, characteristics respectively of the interactions spin-network and the interactions spin-spin, are short. Figure 4 indicates the evolution of the widths to middle height according to the stage $\Delta H_{1/2} = f(s)$.

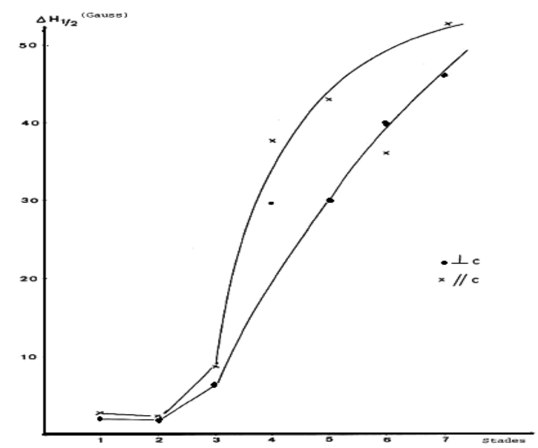

FIG. 4: Variation of the width with middle height of the lines of EPR according to the stage

When the power of irradiation ultra high frequency is changed and that one passes from a low value (attenuation of 12 or 18 dls) to the maximum value (0 dls), the lines of the poor compounds (stage equal to or higher than five) narrow of a factor close to two, that is abnormal because if there were saturation, one should have a widening of these high power lines. For the rich compounds of stage lower or equal to four this change does not have an influence on the shape of these signals. One finds the same effect while working with low power but by heating the sample: for example for the compound of stage seven the width of the line hasmiddle height passes from 46 to 27 gauss when one heats from 0 to 100°C. One could thus be in the presence of a structural transition caused by a significant heating from the sample under the irradiation ultra high frequency and which occurs in this temperature range.

IV- CONCLUSION

For the ternary compounds G-NaH rich (ap to the stage four), there are lines of form dysonienne normal i.e.fine and simple, characteristic of a driver, the anisotropy of the width with middle height is relatively low and the signal varies little according to the temperature. For the poor compounds, there are lines of form dysonienne reversed (B'>B), one notes also a significant anisotropy of $\Delta H_{1/2}$ and the width with the middle height depends on the temperature. This can be explained by the presence of NaH in inclusion (highlighted by the structural study) in these compounds. The sodium hydride which is insulating places between the conducting layers of graphite.

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