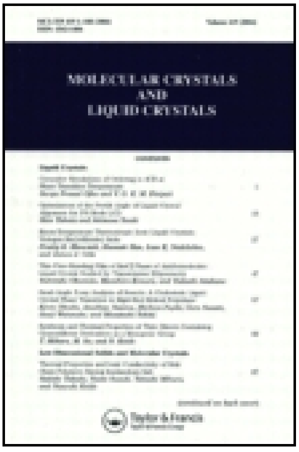

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Measurement of Acoustical Parameters at Reorientation of the Smectic - C Phase

Sergey Pasechnik [a] , Vyacheslav Balandin [a] & Alexander Kashitsin [a]

[a] Moscow Instrument Institute, Strominka 20, I07076, Moscow, USSR

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MEASUREMENT OF ACOUSTICAL PARAMETERS AT REORIENTATION OF THE SMECTIC - C PHASE

SERGEY PASECHNIK, VYACHESLAV BALANDIN,
ALEXANDER KASHITSIN
Moscow Instrument Institute, Strominka 20, I07076
Moscow, USSR

Abstract The results of acoustical investigation of the reorientational process of the smectic - C phase in the 0.3 T magnetic field are presented. The registered variations of the absorption coefficient and velocity of ultrasound on frequencies 3 and 27 MHz when the angle between the magnetic field and the wave vector is varied are accompanied by a distortion of the monodomain structure of the S_c phase, increasing when temperature is lowered.

Among the variety of smectic phases only smectics - C (S_c) are known to be reoriented by a comparetivly weak magnetic field. The investigation of such processes allows to obtain valueable information about its structure.

In this work we studied acoustical properties of the S_c phase of the hexyloxyphenyl ester of decyloxybenzoic acid having the polymorphism:

$$Cr \xrightarrow{38^\circ C} S_x \xrightarrow{44^\circ C} S_c \xrightarrow{77.6^\circ C} S_A \xrightarrow{83.6^\circ C} N \xrightarrow{89^\circ C} I$$

In the experiment we registered the variations of velocity (c) and absorption coefficient (α) of ultrasound when the sample was reoriented in magnetic field of induction B = 0.3 T. The measurements were produced

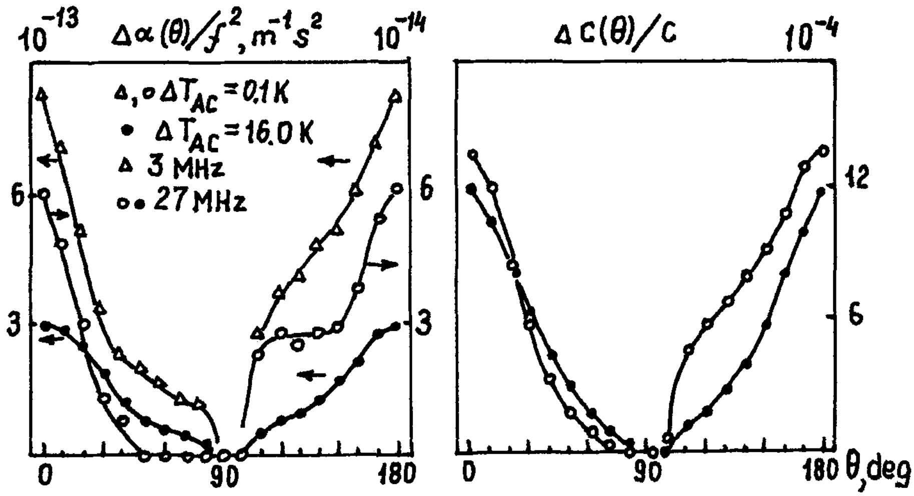

FIGURE I The angular dependences of acoustical parameters.

by the pulse-phase method[I] at frequencies (f) 3 and 27 MHz. The smectic - C phase was prepared by cooling the sample from the nematic phase in magnetic field with $\bar{B} \parallel \bar{q}$,($\bar{q}$ is the wave vector). The sample was then rotated to an angle θ and the variations of acoustical parameters were measured.

The dependences $\frac{\Delta\alpha(\theta)}{f^2} = \frac{\alpha(\theta) - \alpha(90^\circ)}{f^2}$ and $\frac{\Delta c(\theta)}{c} = \frac{c(\theta) - c(90^\circ)}{c(90^\circ)}$ obtained in this way are shown in fig.I for the two values of temperature close to the temperature (T_{AC}) of the S_A - S_c phase transition and far from it. There is a significant difference between the presented dependences and the typical ones obtained for nematics[2]. Near the T_{AC} temperature there are two regions (50 - I00° and II0 - I50°), where $\frac{\Delta\alpha(\theta)}{f^2}$ parameter practically does not depend on θ . It can be observed at high frequencies, when there is no critical contribution to the $\frac{\Delta\alpha}{f^2}$ value, connected with the S_A - S_c phase transition. These regions narrow, when the sample is cooled. We should note, that this peculiarity is weak for the $\frac{\Delta c(\theta)}{c}$ dependence. The results in fig.I probably testify that the S_c phase sample, prepared as described earlier, cannot be considered as an ideal monodomain. Indeed, there will be no variations in acoustical parameters α and c if we suggest that the layer structure of the sample rotated in a weak magnetic field does not change and the values of α and c depend only upon the angle between the director and wave vector in the same way as in nematics.(In this case Ψ = const.). The existence of the angle dependences points to a distortion of the layer structure, which in our opinion cannot be considered as a polydomain[3]. This assumption agrees with our other experiments, which results will be published soon. In particular, these results show the possibility of using the model of S_c phase similar to the monodomain one with small deflections of the layer normals from the direction of the magnetic field in which the sample is cooled. This model deals with the two stable positions of the director when reorienting of the S_c phase in magnetic field, which probably explaines the existence of the two flat regions on the $\frac{\Delta\alpha(\theta)}{f^2}$ dependence. When the temperature is lowered, the angle between the director and the layer normal increases and the distortion of the layer structure becomes great, which results in decreasing of the flat regions on the $\frac{\Delta\alpha(\theta)}{f^2}$ dependence. Besides it causes the increasing of anisotropy of acoustical parameters. This increasing was observed on frequency 27 MHz for $\frac{\Delta\alpha(0)}{f^2}$. In fig.2 solid curve shows the power dependence of $\frac{\Delta\alpha(0)}{f^2} \sim (T_{AC} - T)^{0.3}$ with the exponent close to 0.25 obtained experimentally[4] for the temperature dependence of the tilt angle

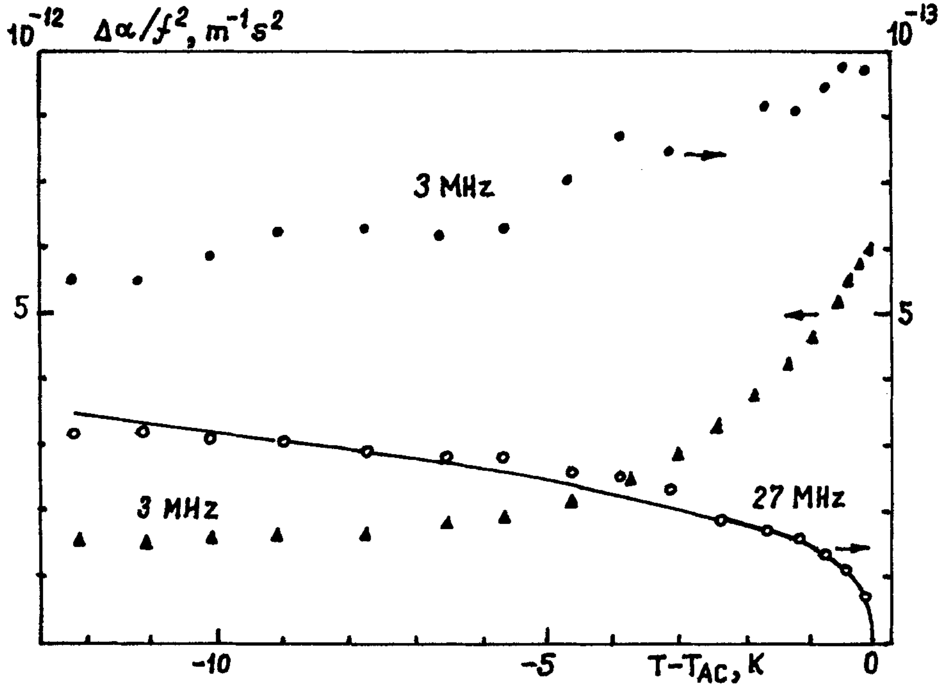

FIGURE 2 The temperature dependence of $\frac{\Delta\alpha(0)}{f^2}$.
▲ - the total anisotropy.

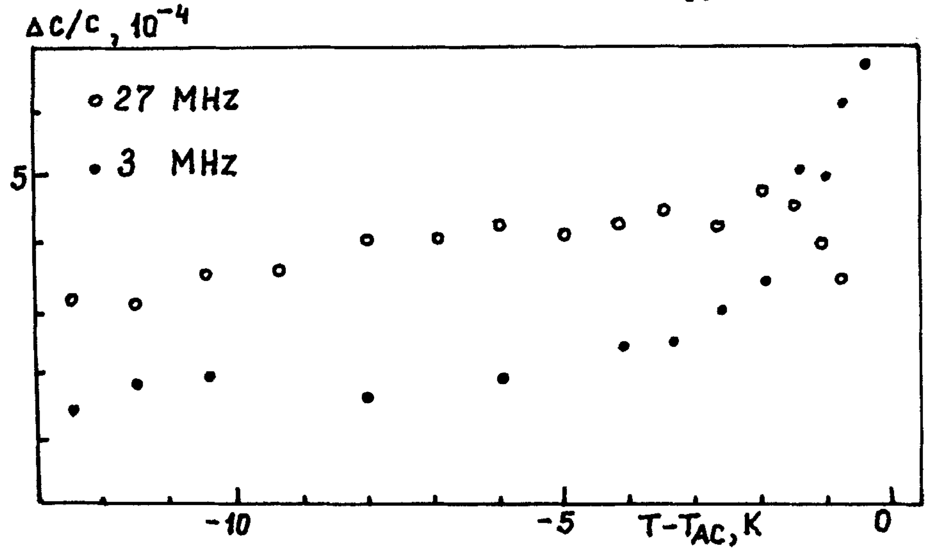

FIGURE 3 The temperature dependence of $\frac{\Delta c(0)}{c}$.

of molecules in this compound. The data on 3 MHz are also shown in fig.2. The increasing of the $\frac{\Delta\alpha(0)}{f^2}$ value when approaching T_{AC} is connected with critical processes in the region of the $S_A - S_C$ transition, which do not reveal themselves on 27 MHz. It is worth mentioning that the velocity anisotropy $\frac{\Delta c(0)}{c}$ is more sensitive to critical processes (see fig.3). This fact probably explains the absence of flat regions on the $\frac{\Delta c(0)}{c}$ curve. The influence of critical processes on character of the angle dependences is also prooved by the $\frac{\Delta\alpha(0)}{f^2}$ data on frequency 3 MHz, shown in fig.I.

In conclusion, it would be interesting to note, that the structure distortion occuring when reorienting the sample in magnetic field is not great compared to the complete reorientation of the layer structure. This is confirmed by the total anisotropy $\frac{\Delta\alpha}{f^2}$ dependence, obtained by cooling the sample in magnetic field when $\bar{B} \parallel \bar{q}$ and $\bar{B} \perp \bar{q}$.

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