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Publisher: Taylor & Francis

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Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/gmcl16>

ResearchNote: On the Activation Energy of a Friction Coefficient of Liquid Crystals

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Version of record first published: 21 Mar 2007.

To cite this article: C. K. Yun (1976): ResearchNote: On the Activation Energy of a Friction Coefficient of Liquid Crystals, *Molecular Crystals and Liquid Crystals*, 35:1-2, 181-182

To link to this article: <http://dx.doi.org/10.1080/15421407608084320>

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Research Note

On the Activation Energy of a Friction Coefficient of Liquid Crystals

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(Received September 2, 1975; in final form January 30, 1976)

Temperature dependence of the friction coefficient $-\lambda_1/\rho$ of a nematic liquid crystal in a range well below its clearing point is expressible in the usual exponential form. Examining data for 24 nematic liquid crystal compounds and mixtures, Flanders¹ observed that they exhibit a common activation energy value 10.9 kcal/mole. Earlier² we obtained values of the friction coefficient for 8 nematic compounds as a function of temperature from a set of old experimental data published by Zwetkoff and Sosnovsky.³ Following Flanders, we have prepared a plot of these data on a semi-log paper to confirm his finding for *p*-azoxyanisole (PAA), *p*-azoxyphenetole (PAP), *p*-methoxycinnamic acid, di-*p*-acetoxybenzalazine, anisaldazine and di-benzalbenzidine (DBB). However, we find that the activation energy for anisal-*p*-aminoazobenzene (APAAB) and di-anisalbenzidine (DAB) is 5.5 kcal/mole, only a half of the more common value. As shown in Figure 1, the smaller value for APAAB could be due to a large experimental error ($\sim 15\%$) at 140.5°C because the slope coincides with DBB and others in a higher temperature range. The slope for DAB is definitely exceptional, though. We note in addition that, at least for PAA and PAP, the coefficients $-\lambda_1/\rho$ and $-\lambda_1$ share practically the same activation energy because of the negligible variation of the mass density ρ with temperature.

It should be an interesting task for a theoretical chemist to explain why the value 10.9 kcal/mole or 0.47 eV per molecule is common to the majority of nematic liquid crystals and why it is almost exactly halved in one or two exceptional cases. It appears that the present understanding on the molecular level of the mechanism of the optic axis rotation in a nematic liquid crystal

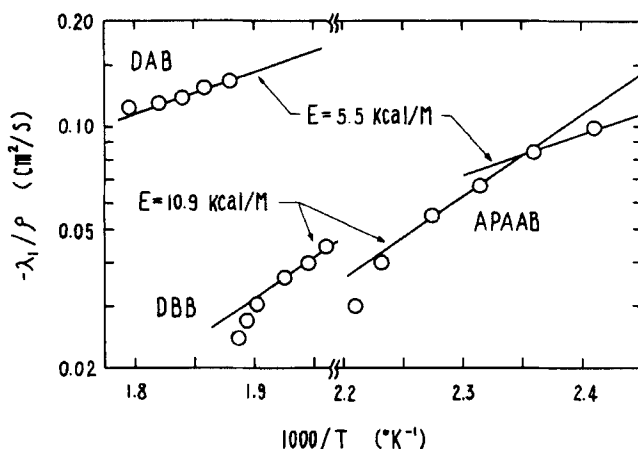


FIGURE 1 Plots of the friction coefficient values on a logarithmic scale vs. inverse of the absolute temperature. The coefficient $-\lambda_1$ is identical to τ_1 in Flanders' and 4η in Zwetkoff-Sosnovsky's notations.

is inadequate. A simple sketch would show that, given the usual intermolecular spacing, it should be very difficult for the rodlike molecules to rotate about their minor axes individually. Perhaps a measurement of the inertial coefficient ρ_1 may suggest something about this.⁴ We need pay more attention to the collisions, clustering and deformation of the molecules when the macroscopic optic axis changes in time, *e.g.* in a rotating magnetic field.

Acknowledgement

I wish to thank Dr. Won Hee Park and Dr. Won-Hoon Park for helpful discussions.

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