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

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# Research Note

## On the Activation Energy of a Friction Coefficient of Liquid Crystals

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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, Flanders[1] observed that they exhibit a common activation energy value 10.9 kcal/mole. Earlier[2] 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 $\rho$ 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

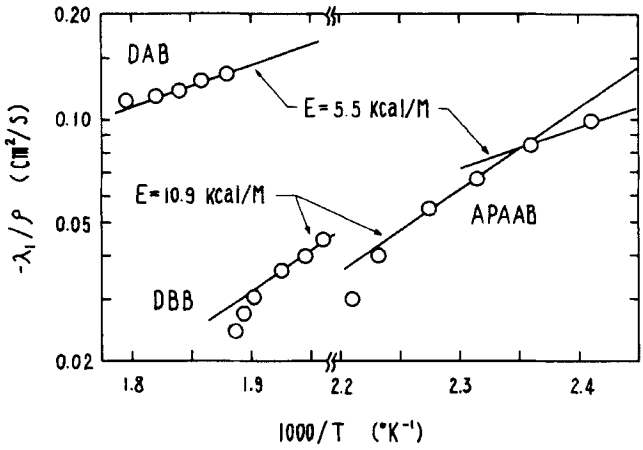


FIGURE 1 Plots of the friction coefficient values on a logarithmic scale *vs.* inverse of the absolute temperature. The coefficient $-\lambda_1$ is identical to $\gamma_1$ in Flanders' and $4\eta$ in Zwetkoff–Sosnovsky's notations.

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 $\rho_1$ 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.

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