Gigantic Increase in Liquid Crystal Transition Temperature in Dimer Molecules Induced by a Magnetic Field

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The liquid crystalline state lies between the liquid and solid states of matter. For example, the nematic liquid crystal state exhibits orientational order of the molecules, but no long range positional order (as would exist in the crystalline state). Whether and how this state forms depends strongly on molecular shape and temperature. External influences, like electric or magnetic fields can also strongly impact the formation of this state.

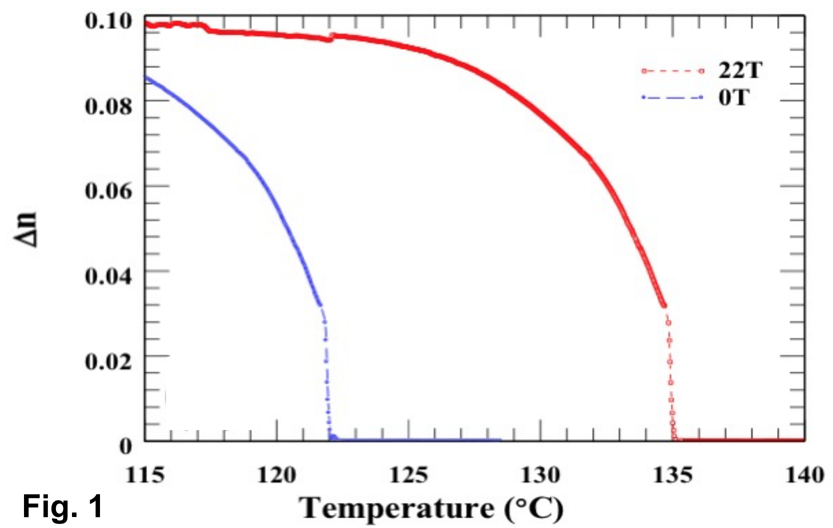

Fig. 1

We study the optical properties of liquid crystalline dimers while they are subject to high magnetic fields; this can both directly and indirectly reveal the effect that molecule shape has on physical properties, including birefringence, the response to polarized light of different orientations. The shape of the dimers can strongly shift the phase transition temperature between different liquid crystalline states. Prior experiments using electric fields or magnetic fields of up to 10T have shown only a very small change in phase transition temperature, sometimes only a fraction of a degree Celsius (i.e. <1C). *The present work (Fig. 1) shows that a 22 Tesla field can shift the transition temperature by as much as 13C, far greater than has ever been previously observed.*

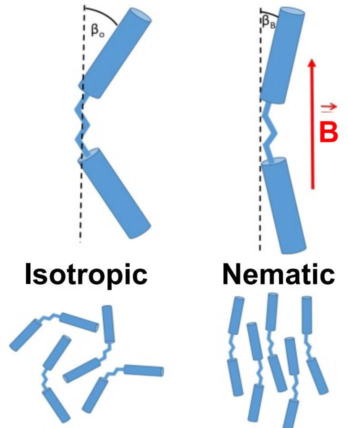

Fig. 2

This gigantic effect is too large to be explained within the framework of molecular statistical theories of the nematic-isotropic (N-I) phase transition. One possible explanation, based upon the diamagnetic properties of these molecules and their flexible *nunchaku* fighting stick shape (Fig. 2), is that *the applied magnetic field alters the molecular shape, effectively straightening them out and affecting the material at the molecular level,* thus changing where the N-I transition occurs. We estimate the effective angle between the arms only needs to increase by a few degrees to explain this effect.

Facilities: 25T Split Helix Magnet, DC Field Facility

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