HIGH-FIELD MAGNETO-OPTICAL STUDIES OF LIQUID CRYSTALS AND COMPLEX FLUIDS

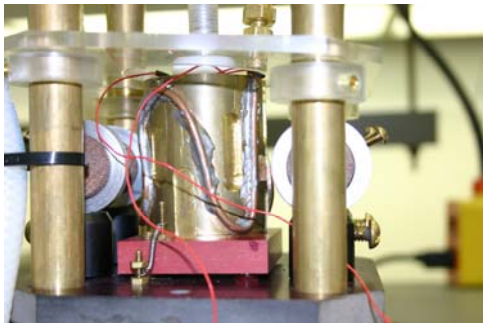
S.N. Sprunt, J.T. Gleeson, A. Jakli, D. Wiant, K. Neupane (Kent State University)

Introduction

Bent core nematic liquid crystals bring exciting opportunities for both new technological applications and fundamental science. Concerning the latter, one important prediction is the existence of a new state of matter, comprised of such liquid crystals which are tetrahedratically ordered. That is, has the orientational symmetry of a tetrahedron, described by a third-rank tensor order parameter. This state will be particularly difficult to identify because it will be optically isotropic, and therefore not detectable via usual techniques. Our approach was to search for this substance using magnetic field induced optical birefringence. Preliminary experiments at KSU showed promising indications, but we could not produce sufficiently intense fields to make definitive conclusions.

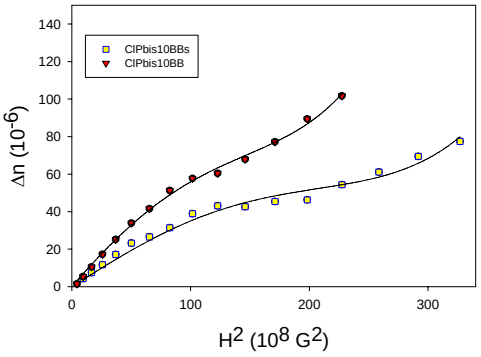
Experimental

We therefore built a custom built oven and stage designed for Cell 4 in Tallahassee. This apparatus folded a laser beam from an optical breadboard on the floor beneath the bore, up to the oven which was held at the bore center, then transverse through the liquid crystal (so that the beam traveled perpendicular to the field) and then back down to the optical breadboard for analysis. These measurements were obtained as functions of both temperature and magnetic field (up to 19T) during May, 2006. A photograph of our oven and tower assembly is at right.



Results and Discussion

Our high magnetic field results, when taken in conjunction with independent dynamic light scattering studies, demonstrate convincingly, for the first time, the existence of the tetrahedratic phase. Example data is shown at right; traditional liquid crystals will exhibit a constant Cotton-Mouton coefficient (i.e. a straight line through the origin). The example clearly indicates non-linear behavior, which is a signature of the tetrahedratic phase.[1] Such data could only be obtained using the non-conventional magnetic field capabilities of NHMFL.



Acknowledgements

This work has been supported by the National Science Foundation (NSF-DMR-0606160) and Kent State University.

References

[1] Wiant, D.B. *et al*, "Observation of a possible tetrahedratic phase in bent-core liquid crystals", submitted to Physical Review Letters, November, 2006.