

Lytotropic Chromonic Liquid Crystals: Structure, Viscoelasticity, and Defects

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Soft non-covalent attraction of organic molecules in solutions often results in elongated aggregates. Examples include "living polymers", worm like micelles of amphiphiles, stacks of disk-like dye and drug molecules, nucleic acids and proteins. In a broad range of concentrations and temperatures, the self-assembled polydisperse aggregates form nematic and columnar liquid crystal (LC) phases, generally classified as lyotropic chromonic liquid crystals (LCLCs). Since the aggregates are bound by weak van der Waals forces, their length varies strongly with concentration, temperature, ionic content, making the LCLCs very different from standard thermotropic LCs with molecules of covalently fixed shape and from lyotropic LCs formed by objects such as tobacco mosaic viruses or polymers of fixed molecular weight. Despite the growing interest to these materials fueled by a potential of promising applications, very little is known about the details of their structure. An intriguing question is how the weak character of association within the chromonic aggregates reflects on macroscopic properties, such as viscoelasticity and topological defects. The presentation discusses recent experimental advances in the field: (1) the role of ionic and crowding agents in the phase behavior of the LCLCs; (2) concentration and temperature behavior of splay, twist, and bend elastic constants and orientational viscosities; (3) structure of tactoids and topological defects in LCLCs. Much of the work was performed in collaboration with the Institute of Physics (Kyiv) and Institute of Physical Optics (Lviv) and supported by NSF (USA) DMR grants 076290 and 11212878, by the Ministry of Education, Science, Youth and Sport of Ukraine (Grant No. 0111U010235), by Grants DFFD F35/534-2011 and NASU 1.4.1B/10.