July 16-21, 2017 at UC San Diego, CA, USA

Intricate behavior of 4-base nanoDNA sequences: an intersection between condensed matter and RNA world

G. P. Smith[1], T. P. Fraccia[2], M. Todisco[2], C. Zhu[3], T. Bellini[2], D. M. Walba[4] and N. A. Clark[1,*]
[1]Department of Physics and Soft Materials Research Center, University of Colorado, Boulder, CO, 80309-0390, [2]Dipartimento di Biotecnologie Mediche e Medicina Traslazionale, Università di Milano, via Fratelli Cervi 93, I-20090 Segrate (MI), Italy, [3]Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, CA 94720 USA, [4]Department of Chemistry and Soft Materials Center, University of Colorado, Boulder, CO, 80309
*e-mail of Correspondence Author: Noel.Clark@colorado.edu

Introduction: nanoDNA are short sequence DNA oligomers having ~20 or fewer A, T, G or C nucleotide bases, that can form liquid crystal phases if they have the appropriate combination of complementarity, hydrophobic end-stacking, and/or sticky-end hydrogen bonding (G sticking to C or A to T) when dissolved in water [1]. nanoDNAs are of interest in an origins-of-life context because their LC phases can effectively catalyze DNA autoligation and create longer sequences from shorter ones in the absence of protein catalysis [2]. As a bridge between ligation mediated by intermediate length nanoDNA oligomers and LC formed from single-base monomers [3], we pursue a general characterization of the self-assembly and phase behavior of particularly short 4 base DNA sequences, including GCCG, GTAC, and ATTA, as a function of both concentration and temperature. GCCG, which assembles into Watson-Crick duplexes by 2X2 sticky-end base pairing, and which also forms G-quartets, exhibits coexisting LC [Figure 1], crystalline and glassy phases. Watson-Crick duplexes appear to dominate in fresh GCCG mixtures, but tend to settle into a more complicated crystal structure over time. The crystal structure is a network of sites on a square lattice where sets of four GCCG molecules come together to form an H-bonded quartet. At especially high concentrations, GCCG exhibits a reentrant isotropic phase which we interpret as a glassy G-quartet mediated structure.

References: [1] Nakata M et al (2007) *Science* **318**, 1276, DOI: 10.1126/science.1143826 [2] Fraccia TP et al. (2015) *Nature Communications* 6:6424, DOI: 10.1038/ncomms7424. [3] Smith GP et al (2017) *Origins XXVIII*, Abstract #4185.

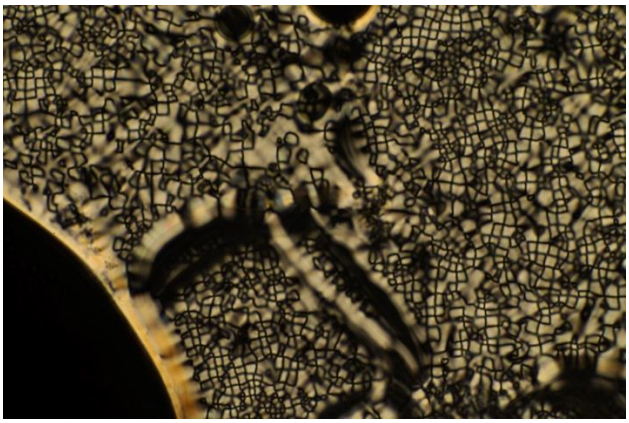

Figure 1 – Polarized light microscope image of GCCG aqueous mixture chloesteric LC phase with parabolic focal conic defect structure.

Additional Information: This work supported by NSF Biomaterials Grant DMR-1207606, NSF MRSEC Grant DMR-1420736. ALS Beamline 7.3.3 is supported by U.S. DoE under contract No. DE-AC02-05CH11231.