Confinement induced phase transition in a DNA-lipid hydrated complex

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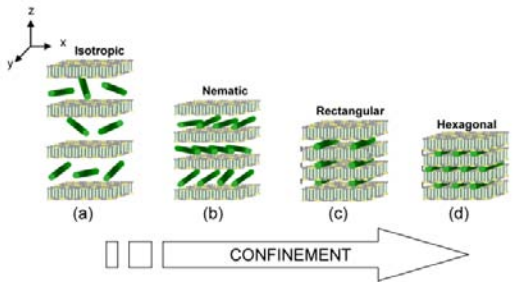
We study the effect of the soft confinement by fluid lipid bilayers on the spatial organization of DNA molecules in a DNA/zwitterionic lipid hydrated lamellar complex. The confinement is increased by dehydrating the complex in a controlled way, which leads to a decrease of the water channel thickness separating the periodically-stacked bilayers. Using grazing-incidence small-angle x-ray scattering on an oriented thin film, we follow in situ as dehydration proceeds the structure of the DNA-lipid complex. A structural phase transition is evidenced, where the "classical" 2D nematic phase of DNA rods embedded within the one-dimensionally ordered lipid lamellar phase observed at high hydration is replaced by a new 2D hexagonal structure of DNA molecules intercalated between the lipid bilayers.

In order to correlate the structural and diffusive properties of the system, we started "surgical" FRAP (Fluorescence Recovery after photobleaching) experiments, using a confocal microscope (CLSM) on oriented samples. We have identified three modes of DNA diffusion: an isotropic diffusion, where the molecules in each layer are randomly distributed and randomly orientated, a noncorrelated nematic anisotropic diffusion, with a directional order in each layer but no correlation between neighbouring layers, and finally a correlated nematic anisotropic diffusion with correlation between neighbouring layers. Further we present a method of data analysis that allows to distinguish between isotropic and anisotropic diffusion, when averaging over several layers of a lamellar phase in homeotropic orientation.