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Assembling and rigidifying DNA macromolecules by ionic liquids

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Deoxyribonucleic acid (DNA) is a negatively charged bio-macromolecule that helps in the transmission of genetic information for the growth and functioning of a living organism. Therefore, it is considered as a potential tool in gene therapeutics. Packing or condensing of this macromolecule is difficult because of the intra and intermolecular repulsive electrostatic and entropic interactions. Even though there are reports of condensing the molecule using inorganic salts in bulk aqueous medium, the assembly at the air-water interface is rarely reported. Here, we report the assembly of the DNA molecule at the interface induced by an imidazolium based ionic liquid (IL) 1,3 didecyl-2-methylimidazolium chloride. The surface pressure-area isotherm ensures the presence of the molecule at the interface with a high mean molecular area. Interfacial rheology measurements quantify the elastic nature of the molecular film. The storage and loss modulus of the film is found to strongly depend on the in-plane pressure. Advanced in-situ synchrotron X-ray reflectivity (XRR) study relates these physical properties of the film with its structure. The electron density profile of the film across the interface manifests the compact nature of the film in presence of the IL. This work suggests an easy way of immobilizing the DNA macromolecule at the air-water interface. The work has been extended to bulk aqueous solution of DNA in presence of the organic salt. Small angle X-ray scattering (SAXS) results indicate rigidification of the DNA strands in presence of the IL which is opposite of what is reported for an inorganic salt. Computational analysis of the work has provided the molecular details of this exceptional behavior in presence of the organic salt.

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Primary authors: Prof. GHOSH, Sajal Kumar (Shiv Nadar Institution of Eminence); Ms SHARMA, Gunjan (Shiv Nadar Institution of Eminence)

Co-authors: Dr GUPTA, Ritika (Shiv Nadar Institution of Eminence); Mr TEMPERINI, Tommaso (University of Rome "La Sapienza"); Dr GIRI, Rajendra Prasad (Kiel University); Dr MURPHY, Bridget (Kiel University); Prof. MICHELE, Cristiano De (University of Rome "La Sapienza")

Presenter: Prof. GHOSH, Sajal Kumar (Shiv Nadar Institution of Eminence)

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