Stimuli-responsive hierarchical self-assemblies of DNA-polymer hybrids

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Chemical functionality and shape anisotropy in colloidal particles hold a great promise to provide new programmed approaches of self-assembly. Here, inspired by the hierarchical self-assembly concept with block copolymers and exploiting the unique DNA's physicochemical properties, a novel family of DNA-polymer hybrids is constructed. These stimuli-responsive hybrids consist of a charged rigid DNA and a neutral temperature-responsive flexible polymeric segment which are covalently connected. The polymeric patches and rod-like DNA backbone display charge and flexibility difference. Moreover, a chemical mismatch between DNA and the polymeric block results in tunable amphiphilicity. Thus, it is possible to reversibly switch between a disordered ensemble and different multidimensional nanostructures of increasing complexity simply by changing the temperature. The formation of different self-assembled structures can be identified by small angle X-ray scattering (SAXS). SAXS measurements have been carried out in aqueous solutions of DNA-polymer hybrids and revealed phases ranging from lamella to cubic morphologies. Additionally, Brownian dynamics simulations provide a deeper insight into the molecular organization of cubic network phases. The results obtained show that this approach can be applied to different DNA architectures and significantly contribute to the structural DNA nanotechnology field.