Coating of single DNA molecules by recombinant protein diblock copolymers

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Coating DNA is an effective way to modulate its physical properties and interactions with the environment. However, current (chemosynthetic) DNA-binding polymers form unstable DNA aggregates with random size and shape. This is in part due to the inherent polydispersity of chemosynthetic polymers. In this study, two monodisperse protein diblock copolymers were produced at high yield in recombinant yeast. They carry a large hydrophilic colloidal stability block (~400 amino acids) linked to a short binding block (~12 basic amino acids). Light scattering and atomic force microscopy showed that plasmid DNA complexed with these protein polymers is present as highly stable nanorods. Each rod consisted of protein-coated single plasmid DNA molecules, reminiscent of a cylindrical virus. We propose that inter- and intra-molecular bridging of DNA molecules is prevented completely by the small size of the binding block attached to the large colloidal stability block. The design of the protein diblocks that we have studied can be considered as a scaffold that can be further tuned and extended for improved application in DNA-based nanotechnology and non-viral gene delivery.