

Structure, assembly and mechanical properties of DNA nanoparticles condensed with PEIm

DNA is an anionic polyelectrolyte, which occupies a large volume in salt free solution due to the coulomb repulsion between the charged groups. In the presence of polymer cations, DNA condenses into nanoparticles. DNA nanoparticles have generated a lot interest as a preferred vehicle for delivering therapeutic DNA in gene therapy. The efficiency of gene delivery is determined by stability and compactness of the particles. However not much is known about the organization of DNA within the particles. The large polymer cations condense DNA rapidly, with no distinct intermediate stages that give insight into the arrangement of DNA within the nanoparticle. In our work, we modulate the DNA length to slow down nanoparticle formation; and, by imaging with Atomic Force Microscopy, reconstruct the stages in the particle assembly. The polymer cation used was Polyethyleneimine with 3% grafted mannobiose (PEIm). The cation to base pair ratio was $\sim 30:1$. The DNA was found to be arranged within the nanoparticle as an inter-weaving network of fiber condensates. The fiber condensates form from DNA condensing along its length, and appear to be the unit of DNA organization within the particle. The fiber-condensate network was found to be highly deformable, having as much as 95% water content. Nano-indentation experiments suggest that the nanoparticles have a hollow sphere structure. Understanding how DNA is organized within a nanoparticle is critical for modulating its stability and release dynamics within the cell to maximize gene delivery efficiency.