Charge inversion phenomenon in DNA/cationic nanoparticle complexes[1]

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In chromatin, long negative DNA duplex winds around positively charged histone octamers and forms complexes which are called nucleosomes. When the nucleosomes are enzimatically isolated it is observed that they carry a negative net charge [1] indicating that more DNA is wrapped around histone octamer than required for its electroneutrality. To gain a deeper insight into DNA/histone interaction, biomimetic complexes between DNA and positively charged nanoparticles (NPs) are studied. In addition to their fundamental significance, these systems are of interest as efficient gene delivery systems capable to overcome the ever recurring problems of transfection efficiency [2-4].

In this work, we studied the evolution of charge in the DNA-NP system for cationic nanoparticles of different size (15 and 100 nm) and at different ionic strength (1 and 10 mM NaCl). Fluorescent microscopy (FM) and FM-combined gel electrophoresis were used to investigate the conformation and the charge of DNA-NP complexes at a single DNA chain level, while parallel zeta potential measurements of the same samples were performed to get information about the charge properties of these complexes at the level of molecular ensemble. For nanoparticles of both sizes it was found that at the point of complete DNA compaction, the total charge on DNA-NP complex is negative, i.e. nanoparticles are overcharged by DNA segments in a similar way as it was found in complexes of DNA with histone proteins. In the excess of nanoparticles, complexes are overcharged by nanoparticles bearing positive charge. It was further found that degree of overcharging of NP with DNA at the point of complete DNA compaction is higher at lower ionic strength, while the charge of such overcharged complexes is similar for the both sizes of nanoparticles.

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