Photoluminescent carbon quantum dot/poly-L-Lysine core-shell nanoparticles: A novel candidate for gene delivery

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Abstract

Cationic polymers such as poly-L-lysine (PLL) are able to interact electrostatically with DNA to produce polymeric systems with nanometric diameters due to the neutralization and accumulation of DNA. This study integrates the outstanding properties of carbon quantum dots (CQDs) with PLL to develop a novel gene delivery vehicle with a core-shell hybrid nanostructure. The CQD/PLL core-shell nanoparticles (NPs) were, therefore, synthesized in such a way that they had narrow size distribution and an average diameter under 10 nm, both of which were confirmed by dynamic light scattering (DLS) and transmission electron microscopy (TEM). Fourier transform infrared (FTIR) spectroscopy exhibited that the PLL passivation agents were formed on the CQDs through releasing amine groups on their surface. The positive charge of the CQD/PLL core-shell NPs reduced from +15 to nearly zero mV after being loaded with DNA at the weight ratio of 2:1. These traceable, water-soluble, biocompatible, and tunable photoluminescent NPs demonstrated a quantum yield of around 12% and a cellular uptake of nearly 70%. The NPs also showed no considerable toxicity to the human embryonic kidney (HEK)-293T cells. Hence, these novel CQD/PLL core-shell NPs hold great promise as a non-toxic and efficient gene delivery vector.

Keywords

Carbon quantum dot, Poly-L-lysine, Nanoparticles, Gene delivery