Next-Generation Quantum Dots for Molecular and Cellular Imaging

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Abstract

Semiconductor quantum dots, tiny light-emitting particles on the nanometer scale, are emerging as a new class of fluorescent labels for a broad range of molecular and cellular applications. In comparison with organic dyes and fluorescent proteins, they have unique optical and electronic properties such as size-tunable light emission, intense signal brightness, resistance to photobleaching, and broadband absorption for simultaneous excitation of multiple fluorescence colors. Here we report new advances in minimizing the hydrodynamic sizes of quantum dots using multidentate and multifunctional polymer coatings. A key finding is that a linear polymer containing grafted amine and thiol coordinating groups can coat nanocrystals and lead to a highly compact size, exceptional colloidal stability, strong resistance to photobleaching, and high fluorescence quantum yields. This has allowed a new generation of bright and stable quantum dots with small hydrodynamic diameters between 5.6 nm to 9.7 nm with tunable fluorescence emission from the visible (515 nm) to the near infrared (720 nm). These quantum dots are well suited for molecular and cellular imaging applications in which the nanoparticle hydrodynamic size needs to be minimized. Together with the novel properties of new strain-tunable quantum dots, these findings will be especially useful for multicolor and super-resolution imaging at the single-molecule level.