Efficiency of biocompatible quantum dots for cellular imaging using confocal laser scanning microscope

THESIS

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List of Abbreviations

0D	Zero-dimensional
1D	One-dimensional
2D	Two-dimensional
3D	Three-dimensional
B. subtilis	*Bacillus subtilis*
Cd-QD	Cadmium based QD
CdSe	Cadmium selenide
CdSe/ZnS	Cadmium selenide/ Zinc sulfide core/shell
CdSe/ZnS-SiO_2 QDs	Silica coated CdSe/ZnS
CLSM	Confocal laser scanning microscopy
Chlamydomonas reinhardtii	*C. Reinhardtii*
DLS	Dynamic light scattering
EDX	Energy dispersed X-ray
eV	Electron Volt
FBS	Fetal bovine serum
FRET	Förster resonance energy transfer
GQDs	Graphene quantum dots
GO	Graphene oxide
G-SiO_2	Silica coated Graphene Quantum Dots
HepG2	Liver hepatocellular carcinoma
HRTEM	High-resolution TEM
LaB6	Lanthanum hexaboride
LMPA	Low melting agar
NPs	Nanoparticles
NIR	Near infra-red
NMA	
nm	Nanometer
OD	Optical density
OD_{450}	Optical density at 450 nm
OD_{730}	Optical density at 730 nm
PDI	Polydispersity index
PL	Photoluminescence
QDs	Quantum dots

QY	Quantum yield
meV	Milli electron Volts
NCs	Nanocrystals
TEM	Transmission electron microscope
THF	Tetrahydrofurane
XRD	X-ray diffraction
SCG	Single cell gel assay
SE	Standard error
SiO_2	Silicon oxide
SPT	Single particle tracking
TOP	Tri-n-octylphosphine
TOPO	Tri-n-octylphosphine oxide
ZnS	Zinc sulfide

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Abstract

Quantum dots (QDs) are zero-dimensional systems wherein charge carriers (i.e., electrons and holes) are confined in all three dimensions. QDs are a very interesting nanomaterial with unique characteristics, which could help in many clinical and pharmaceutical purposes.

In this study, we aimed to investigate the efficiency of silica-coated CdSe/ZnS (CdSe/ZnS-SiO_2 NCs) and Graphene nanocrystals (GQDs) for imaging purposes. CdSe quantum dots (QDs) were synthesized by organometallic routes and were coated with ZnS shell by injecting solutions of diethylzinc ($Zn(Et)_2$) and hexamethyldislathiane ($(TMS)_2S$) as precursors for zinc and sulfur ions respectively. On the other hand, GQDs were synthesized via glucose pyrolysis. Then, the prepared NCs overcoated with silica using tetraethyl orthosilicate (TEOS) as a silica precursor. QDs were characterized by UV-Vis absorption, emission spectroscopy TEM, XRD, and DLS. The biocompatibility of silica-coated QDs was tested by evaluating mitochondrial activity and alkaline comet assay of liver

hepatocellular carcinoma (HepG2) cells exposed to different concentrations of QDs. The intracellular uptake and localization of QDs in HepG2 cells, *Bacillus subtilis* (*B. subtilis*) and *Chlamydomonas reinhardtii* (*C. reinhardtii*) were monitored by fluorescence imaging using Confocal Laser Scanning Microscopy (CLSM) up to eight hours. Results showed that silica coating yielded final particles' size around 30 nm possessing strong luminescence property. The cytotoxicity test results showed that CdSe/ZnS-SiO_2 were nontoxic at low concentrations. CLSM showed that HepG2 cells depicted fast internalization of CdSe/ZnS-SiO_2 into human, bacterial and algal cells. While GQDs showed higher biocompatibility and good ability to internalization inside human cells however it showed internalization inside neither bacteria nor algae.