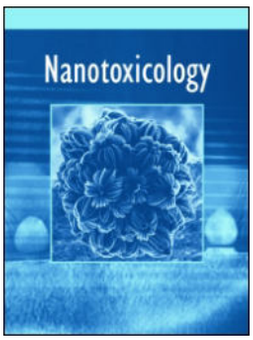

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ARTICLE

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Cytotoxicity of nanoparticles - Are the size and shape only matters? or the media parameters too?: a study on band engineered ZnS nanoparticles and calculations based on equivolume stress model

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ABSTRACT

Size dependent cytotoxicity of ZnS nanoparticles (NPs) was investigated in Human embryonic kidney (HEK-293) cell lines by MTT assay. The cells were incubated with varying concentration of ZnS NPs of sizes 4 nm, 10 nm and 25 nm for 48 h under different (cell culture) media viscosity conditions. The results showed that the toxicity is decreased with the particle size while it is negatively correlated with the viscosity of the media. Theoretical calculations were performed, by assuming equivolume stress model and the same is explained with schematics. Similarly, the effect of particle size and shape on toxicity is explained based on the theoretical calculation of the stress. The calculations showed that out of the possible cellular entry mechanisms for the cubic or cage shaped NPs, the highest toxicity is predicted for the entry through the corners while the lowest toxicity is predicted for the entry through the faces. The experimental observations depicting the cytotoxicity as a function of the viscosity of cell culture media was also validated by stress calculations and are found to be consistent. Studies on size and shape dependence of semiconductor NPs like ZnS is rather scarce, while the role of viscosity of cell culture media on the cytotoxicity is being reported for the first time. In summary, the study indicates that the cytotoxicity is an integral function of size and shape of NPs, physical parameters of the cell culture media in addition to the post entry biochemical interactions with the host cell.

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Nanoparticles; co-precipitation method; optical characteristics; MTT assay

Introduction

Recently, the research on bio applications of nanomaterials gained much momentum due to their direct application in diagnosis and therapy (Baetke, Lammers, and Kiessling 2015; Menon et al. 2013). Targeted drug delivery, bio imaging, bio sensing, and hyperthermia are some among the various bio applications of nanomaterials (Mornet et al. 2004; Moghimi, Hunter, and Murray 2005; Boisselier and Astruc 2009) and numerous nanosystems have been developed for bio imaging, disease diagnosis, and therapy (Baetke, Lammers, and Kiessling 2015; Menon et al. 2013). Research in this area has a great translational potential. Based on the chemical composition, the nanosystems can be divided into organic and inorganic systems. Organic materials like micelle, liposome, vesicle, peptides, and other synthetic organic materials possess high degree of biocompatibility, biodegradability, and low toxicity levels (Jin et al. 2012; Zhang et al. 2012). However, their stability is less and size tunability is rather difficult. Another group is carbon-based nanomaterials including carbon nanotube, graphene and fullerenes (carbon-based compounds and molecules) that has application potential in wide field of biology and medicine (Roldo and Fatouros 2013; Yuqi et al. 2013).

Inorganic materials often possess better stability and tunability of optical and surface properties due to their ease in synthesis and particle size tailoring

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