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Protein-corona formation on aluminum doped zinc oxide and gallium nitride nanoparticles

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Abstract

The interaction of semiconductor nanoparticles with bio-molecules attracts increasing interest of researchers, considering the reactivity of nanoparticles and the possibility to control their properties remotely giving mechanical, thermal, or electrical stimulus to the surrounding bio-environment. This work reports on a systematic comparative study of the protein-corona formation on aluminum doped zinc oxide and gallium nitride nanoparticles. Bovine serum albumin was chosen as a protein model. Dynamic light scattering, transmission electron microscopy and X-ray photoelectron spectroscopy techniques have been used to demonstrate the formation of protein-corona as well as the stability of the colloidal suspension given by BSA, which also works as a surfactant. The protein adsorption on the NPs surface studied by Bradford Assay showed the dependence on the quantity of proteins adsorbed to the available sites on the NPs surface, thus the saturation was observed at ratio higher than 5:1 (NPs:Proteins) in case of ZnO, these correlating with DLS results. Moreover, the kinetics of the proteins showed a relatively fast adsorption on the NPs surface with a saturation curve after about 25 min. GaN NPs, however, showed a very small amount of proteins adsorbed on the surface, a change in the hydrodynamic size being not observable with DLS technique or differential centrifugal sedimentation. The Circular Dichroism analysis suggests a drastic structural change in the secondary structure of the BSA after attaching on the NPs surface. The ZnO nanoparticles adsorb a protein-corona, which does not protect them against dissolution, and in consequence, the material proved to be highly toxic for Human keratinocyte cell line (HaCaT) at concentration above 25 μg/mL. In contrast, the GaN nanoparticles which do not adsorb a protein-corona, show no toxicity signs for HaCaT cells at concentration as high as 50 μg/mL, exhibiting much lower concentration of ions leakage in the culture medium as compared to ZnO nanoparticles.

Keywords

Protein-corona, nanoparticles, ZnO, GaN, cell viability

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