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Nanotechnologies — In vitro acute nanoparticle phototoxicity assay

Nanotechnologies — Essai in vitro de phototoxicité aiguë des nanoparticules

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Phototoxicity (PT) is defined as a toxic response to an organism exposed to a substance, where the response is either elicited or increased (apparent at lower dose levels) after subsequent exposure to light, or that is induced by skin irradiation after systemic administration of a substance. The increasing use of nanomaterials in various industries also leads to increased exposure, especially to skin. Furthermore, some nanomaterials are used in commercial sunscreens. Hence, possible impacts on human health including detrimental chemical reactions in the presence of light (both natural and artificial) or photo-protective effects, is of interest.

PT is based on a quantum phenomenon. The absorption of a photon with sufficient energy generates an electron-hole pair that can migrate to the nanoparticle (NP) surface and react with water and oxygen, thus forming extremely reactive radicals and reactive oxygen species (ROS). Generation of the ROS by some wide-bandgap materials, such as TiO_2, ZnO, WO_3, CeO_2, carbon nanotubes, quantum dots and some metal NPs when illuminated by UV-VIS light, can cause oxidative stress, resulting in toxic effects in living organisms. Absorption of a photon with sufficient energy is the necessary condition for photochemical reactions to induce phototoxic response. Material PT is closely related to photocatalytic activity (PCA). Measurement of PCA under physiological conditions allows for an assessment of its phototoxicity potency (see ISO 20814).

A wide variety of light sources, light exposure levels, cell lines, incubation times, viability assays, used for nanomaterial PT measurement hamper data comparison. Existing PT standard test methods for soluble chemical substances (e.g. OECD 432) are not directly applicable to determine nanomaterial PT. It states that DMSO or EtOH should be used as cosolvents in case the material is not soluble in water with additional tests for cosolvent toxicity. The method is not applicable for particulate materials.

The in vitro NP PT test is intended to evaluate the nanomaterial acute phototoxicity when exposed to a near ultraviolet (UVA) light. Cell viability is assessed at a fixed NP concentration after exposure to six doses of the UVA light.