

Phototoxicity and dosimetry of nano-scale titanium dioxide in aquatic organisms

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We have been testing nanoscale TiO₂ (primarily Evonik P25) in acute exposures to identify and quantify its phototoxicity under solar simulated radiation (SSR), and to develop dose metrics reflective of both nano-scale properties and the photon component of its potency. Several exposures of medaka larvae have been completed in low ionic-strength water; an approach that consistently yields initial mean initial aggregate sizes of approximately 200 to 300 nm and does not involve the use of aggressive solvents or high-energy (probe sonication) techniques. Under these conditions, the LC₅₀ value is estimated to be 2.42 mg TiO₂/L (CI = 2.3 to 2.51), under levels of SSR equal to approximately 25 to 30% of clear-sky summer sunlight (in Duluth, Minnesota). In the absence of SSR the LC₅₀ value is estimated to be ~ 383 mg/L. Reciprocal testing of pre-irradiated TiO₂ (without fish), and fish pre-exposed (without of SSR) indicate that phototoxicity is not dependant on either relatively long-lived modification TiO₂, or on uptake the material prior to irradiation. Similar approaches have also been used in 48-hr assays with *Daphnia magna*, resulting in an LC50 of 216.3 µg TiO₂/L (CI = 169 to 288); about an order of magnitude lower relative to medaka. No toxicity was observed at levels up 500 mg TiO₂/L under room standard laboratory. These findings provide the basis for a realistic assessment of the importance of solar radiation in estimating hazard and risk for TiO₂. Nano scale- specific and photon-based dose metrics will be also be discussed.