Nanoparticle stability and size as important factors in nano-TiO2 toxicity in macrophage-like cells.

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Keywords: Nanomaterial, TiO2, cytotoxicity, macrophages
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OECD identified TiO2 NPs as one of priority manufactured nanomaterials for toxicology and risk assessment so as to avoid adverse effects from the use of this material (OECD 2010).

Toxicity of TiO2 NMs relies on characteristics of NMs such as shape, size, crystal structure, zeta potential, aggregation and agglomeration tendency, surface characteristics and coatings. However, their influence to toxicity remains unclear due to ambiguous results from different studies (Shi et al., 2013). In vivo studies revealed target organs (spleen and liver) and macrophages seem to be target cells as they have to cope with engulfed TiO2 NMs load.

The presented study measured the cytotoxic effect without photoactivation of fourteen diver TiO2 NMs on human monocytes cell lines THP-1 differentiated into macrophage-like cells.

A set of NM consists of 5 variants of anatase and 5 variants of rutile nanoparticles differing in their diameter (from 3 to 165 nm), 3 variants of anatase high aspect ratio nanomaterials of different widths and lengths and one silicon coated (hydrophobic) rutile particles. TiO2 samples were characterized in the powder form using following methods: X-ray diffraction, thermogravimetric analysis and Brunauer Emmett Teller measurements. Following dispersion, the size distribution in water and cell culture medium and zeta potential in cell culture medium were measured by dynamic light scattering.

Three cytotoxicity assays were used: MTS, WTS-1, and LDH. For all nanomaterials, three independent repetitions were carried out.

Over all, cytotoxicity of all NMs was low even at the highest concentration of 256 µg/ml. The viability did not decrease below 60% for WTS-1 and MST assays and 80% for the LDH assay. Despite low toxicity, polydispersity index, besides concentration, was identified as the important cytotoxic factor. More stable suspension led to higher cytotoxicity.

Crystal size seemed to have also an influence.

There is visible a nonlinear shape for crystalline size and cytotoxicity relationship with the highest toxicity between 20-60 nm (Fig. 1). Nonlinear relationship was also shown in Chang review (2013) who concluded that the highest toxicity occurred within particles with diameter between 10-40 nm. Zhang et al. (2012) found TiO2 NPs with diameter 21 ± 3 nm more toxic for mouse macrophages cells than 12 ± 2 nm and 98 ± 20 nm. Increase cytotoxicity in given diameter size range would give an answer to inconsistent findings at size and cytotoxicity relationship.

The authors acknowledge the assistance provided by the Research Infrastructure NanoEnviCz, supported by the Ministry of Education, Youth and Sports (MEYS) of the Czech Republic under Project No. LM2015073, and CENATOX (GACR P503/12/G147) and NANOGEN (MEYS LO1508) projects.