

# EFFECT OF CERIA AND SILICA NANOPARTICLES ON PELAGIC (*THAMNOCEPHALUS PLATYURUS*) AND BENTHIC (*HETEROCYPRIS INCONGRUENS*) CRUSTACEANS

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## INTRODUCTION

Nanoparticles (dimension 1-100 nm) are of interest because of their unique properties, such as an increased reactivity due to the high surface to volume ratio, light absorbing potential, or magnetic characteristics. Therefore, the production and the number of applications of engineered nanoparticles (NPs) is increasing rapidly worldwide. Current applications include the use of nanoparticles in various areas of the economy, such as textiles, electronics, pharmaceuticals, cosmetics and environmental remediation. The cerium dioxide nanoparticles (CeO<sub>2</sub> NPs) is increasingly being used as a catalyst in the automotive industry and silica dioxide nanoparticles (SiO<sub>2</sub> NPs) are employed in electronics manufacture as both semiconductor and electrical insulator.

In consequence, the fast growing of nano-scale application indicates an important effect on aquatic environment from nanomaterial exposure because NPs can be present in wastewater from domestic and industrial sources and have been targeted for some nano-scale environmental remediation techniques.

In the present study the potential toxic effect of CeO<sub>2</sub> NPs and two types of SiO<sub>2</sub> NPs: positively charged silica coated by Al<sub>2</sub>O<sub>3</sub> (LUDOX® CL) and negatively charged silica (LUDOX® CL-X) was investigated using the acute toxicity test with *Thamnocephalus platyurus* and the chronic toxicity test with *Heterocypris incongruens*.

## MATERIALS AND METHODS

The CeO<sub>2</sub> NPs were obtained from UMICORE in three different sizes (14, 20 and 29 nm; pH 4) as a 10 % (w/w) aqueous suspension at pH 4. However, in standard EPA medium (pH 7.4) these NPs aggregated (mean size 400 nm). Two different silica LUDOX® aqueous suspensions were obtained from Sigma-Aldrich: silica LUDOX CL coated by alumina, containing positively charged nanoparticles (40 nm; pH 4.5) and silica LUDOX CL-X, containing negatively charged nanoparticles (21 nm; pH 9). The silica LUDOX CL in EPA medium aggregated, also. Both commercial suspensions were dialysed at the University of Dublin. Dispersion in the test medium was done according to Van Hoecke et al., *Environ. Sci. Technol.* 2009, 43, 4537-4546.

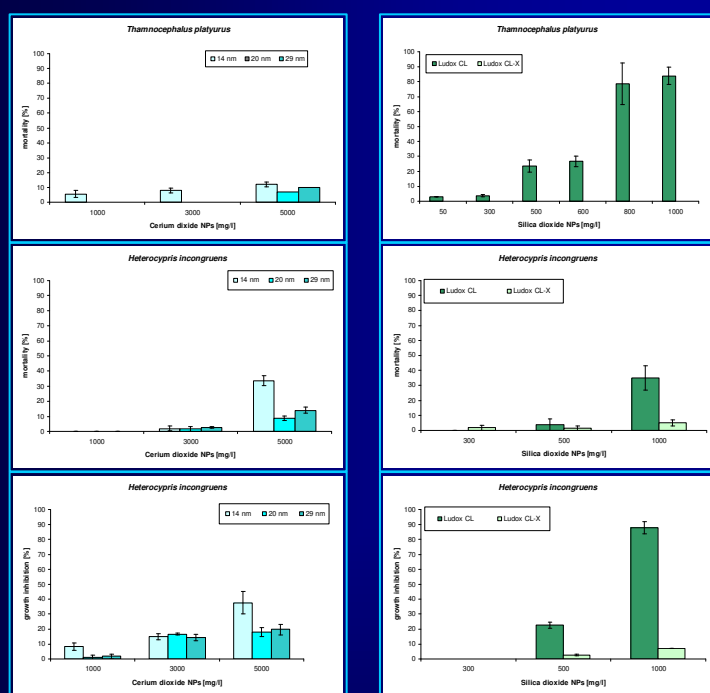


*Thamnocephalus platyurus* is a freshwater anostracan, used in a 24 h acute mortality test (Thamnotoxkit F™). In the acute test, the mortality of organisms is counted after 24 hours. Toxicity is expressed as 50% lethal concentrations (LC<sub>50</sub>). *Heterocypris incongruens* is a benthic ostracod crustacean, used in a 6 days chronic Ostracodtoxkit F test. After 6 days contact with the sediment, the percentage mortality and the growth of the crustaceans are determined.



## RESULTS

Toxic effect of the cerium dioxide NPs and silica dioxide NPs on aquatic crustaceans: pelagic *T. platyurus* and benthic *H. incongruens*\*.

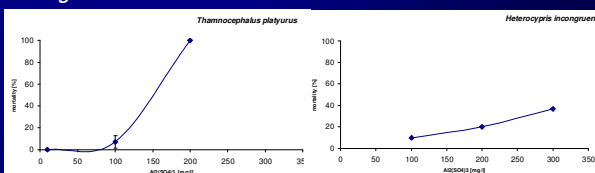


NOEC, LC<sub>x</sub> and EC<sub>x</sub> values of silica LUDOX CL coated by alumina on aquatic crustaceans: pelagic *T. platyurus* and benthic *H. incongruens*\*\*.

	<i>T. platyurus</i>	<i>H. incongruens</i>	
	Lethal concentration [mg/l]	Effective concentration [mg/l]	Lethal concentration [mg/l]
NOEC	300	300	500
LC10	443	-	-
EC <sub>20</sub> /LC <sub>20</sub>	517	487	799
EC <sub>50</sub> /LC <sub>50</sub>	673	652	n.d.

\*\* - NOEC, LC<sub>x</sub>, EC<sub>x</sub> - values were determined using calculation program „ToxRat“, Germany n.d. – not determined, due to mathematical reasons or inappropriate data.

Toxic effect of aluminium sulfate (Sigma-Aldrich) on aquatic crustaceans: pelagic *T. platyurus* and benthic *H. incongruens*.



\* - The sample was classified as toxic when the mortality or growth inhibition was higher or equal to 10% (Thamnotoxkit F™) or 20% (Ostracodtoxkit F); p < 0.05.

## CONCLUSION

- CeO<sub>2</sub> NPs had a slight effect on *T. platyurus* and *H. incongruens* exposed to the maximum concentration tested (5,000 mg/l).
- Positively charged silica NPs (LUDOX® CL) coated by alumina was toxic to *T. platyurus* (LC<sub>50</sub> of 673 mg/l).
- A toxic effect of silica NPs (LUDOX® CL) was also observed on *H. incongruens* (EC<sub>50</sub> of 652 mg/l).
- Silica LUDOX® CL-X was not toxic to both crustaceans at the maximum concentration tested (1,000 mg/l).
- The results of this study indicate an important role of the charged and Al ions in silica NPs activity.
- Generally, the studied nanoparticles should not be a hazard for the aquatic environment according to the EU Directive (Council Directive 67/548/EEC).
- The toxic level should indeed be in the range of 10-100 mg/l... for classification as 'harmful to aquatic organisms and may cause long-term adverse effects...'