

Carbon Nanomaterial Suspension Toxicity Assessment

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I. INTRODUCTION

Nanomaterial is a material with at least one dimension in the size range from approximately 1 nm to 100 nm (<https://cdb.iso.org/>) with properties differing greatly from those of bulk substances. In recent years, development of new manufactured nanomaterials and their multiple applications have boosted toxicity research.

Carbon nanomaterials (CNM) have a low solubility in water, however, surface modification and organic substances, including natural organic matter, increase their solubility and affect CNM fate in environment [1]. Studies suggest that CNM can cause cell and organ toxicity and lethal effects by various routes of exposure [3]. The greatest susceptibility to CNM has been observed for crustaceans and algae with toxic endpoints at 0.25 mg L⁻¹ for fullerene and 8.7 for multi-walled carbon nanotubes (MWCNT) [7].

Biotests with *Daphnia magna* (48h, freshwater, modified ISO standard) and *Artemia salina* (72h, 15 ppm saltwater) were applied to assess non-modified carbon nanomaterial acute toxicity in an aquatic environment.

II. METHODS

Carbon black (CB) nanoparticles (Printex XE2 Evonik Degussa GmbH, average diameter of CB particle 30 nm, specific surface area 950 m²/100g, dibutylphthalate absorption 380ml/100g) and multi-walled carbon nanotubes (Aldrich, outside diameter 40-60 nm, inside 5-10 nm, length 0.5-500 μm) were sonicated (with power 1W/ml) in 100 ml *A. salina* and *D. magna* test medium for 5 minutes to form a stock suspension with total CNM concentration of 10 mg L⁻¹ and diluted for appropriate test concentrations.

Particle solubility changes in response to varying water salinity were measured, and particle sedimentation was assessed parallel to the test. Probit regression analysis was used to assess statistically correct results.

III. RESULTS

Lethal effects for *A. salina* were lower at very high and very low concentrations and were not dose-dependant, reaching the highest mortality at 50% suspensions. In *A. salina* biotest, MWCNT induced more toxic effects than CB nanoparticles. *D. magna* (Figure 1) showed to be more sensitive to CNM with all 48h LC₅₀ observed at total concentrations lower than 2.5 mg L⁻¹. Particle sedimentation experiment (Figure 2) showed that most of suspended particles settled during the first 24h.

IV. CONCLUSIONS

I. Obtained experimental results show that CNM can exhibit toxicity by uptake and by causing physical damage for the test organisms at low concentrations, implying that also non-modified CNM water suspensions are potentially toxic in an aquatic environment.

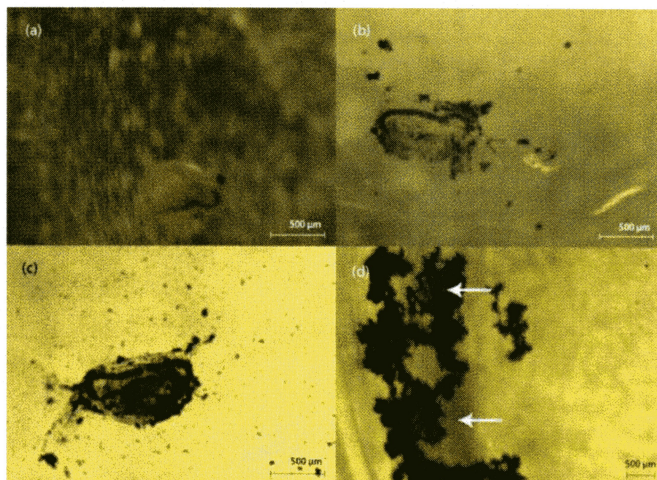


Figure 1. CB effects on *Daphnia magna* (48 h): (a) control with test medium, (b) CB uptake to gastro-intestinal tract and adherence to organism surface in 10% CB suspension, (c) an increased CB uptake and adherence in 17.5% CB suspension, (d) arrows show *D. magna* trapped in CB aggregate in 50% CB stock suspension.

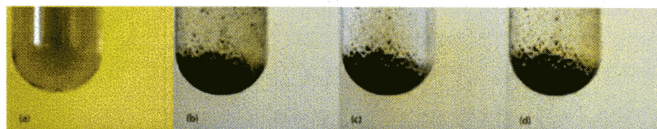


Figure 2. CB particle sedimentation in stock suspension: (a) 30 min, (b) 12 h, (c) 24 h, (d) 36 h after preparation.

V. REFERENCES

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