

國立臺灣海洋大學  
海洋環境與生態研究所 專題討論

中文題目: 奈米氧化鋅對五種海洋生物的毒性－聚集體大小和離子溶解度的影響

英文題目: Toxicities of nano zinc oxide to five marine organisms: influences of aggregate size and ion solubility

作者: Wong et al.

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報告人: 曲昱玲 環態所五年一貫

指導教授: 識名信也老師

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**Abstract**

Nano zinc oxide (nZnO) is increasingly used in sunscreen products, with high potential of being released directly into marine environments. This study primarily aimed to characterize the aggregate size and solubility of nZnO and bulk ZnO, and to assess their toxicities towards five selected marine organisms. Chemical characterization showed that nZnO formed larger aggregates in seawater than ZnO, while nZnO had a higher solubility in seawater ( $3.7 \text{ mg L}^{-1}$ ) than that of ZnO ( $1.6 \text{ mg L}^{-1}$ ). Acute tests were conducted using the marine diatoms *Skeletonema costatum* and *Thalassiosira pseudonana*, the crustaceans *Tigriopus japonicus* and *Elasmopus rapax*, and the medaka fish *Oryzias melastigma*. In general, nZnO was more toxic towards algae than ZnO, but relatively less toxic towards crustaceans and fish. The toxicity of nZnO could be mainly attributed to dissolved  $\text{Zn}^{2+}$  ions. Furthermore, molecular biomarkers including superoxide dismutase (SOD), metallothionein (MT) and heat shock protein 70 (HSP70) were employed to assess the sublethal toxicities of the test chemicals to *O. melastigma*. Although SOD and MT expressions were not significantly increased in nZnO-treated medaka compared to the controls, exposure to ZnO caused a significant up-regulation of SOD and MT. HSP70 was increased two to fourfold in all treatments indicating that there were probably other forms of stress in addition to oxidative stress such as cellular injury.

## 中文摘要

奈米氧化鋅(nZnO) 越來越頻繁的被使用在防曬產品中，因此直接被釋放到海洋環境中的可能性較大。本研究主要在表徵 nZnO 和塊狀 ZnO 的聚集體大小和溶解度，並評估它們對五種選定的海洋生物的毒性。化學表徵表明，nZnO 在海水中形成的聚集體比 ZnO 大，而 nZnO 在海水中的溶解度( $3.7 \text{ mgL}^{-1}$ )高於 ZnO( $1.6 \text{ mgL}^{-1}$ )。本次研究使用海洋矽藻中的骨藻 (*Skeletonema costatum*)和矽藻 (*Thalassiosira pseudonana*)、甲殼類的劍水蚤 (*Tigriopus japonicus*)和凶猛片鉤蝦 (*Elasmopus rapax*)以及青鱗魚(*Oryzias melastigma*)進行了急性試驗。一般來說，nZnO 對藻類的毒性大於 ZnO，但從實驗結果中發現對甲殼類和魚類的毒性相對較小，nZnO 的毒性主要歸因於溶解的  $\text{Zn}^{2+}$  離子。此外，包括超氧化物歧化酶(SOD)、金屬硫蛋白(MT)和熱休克蛋白 70 (HSP70)在內的分子生物標誌物被用於評估測試化學品對青鱗魚的亞致死毒性。儘管與對照組相比，經 nZnO 處理的青鱗魚中 SOD 和 MT 的表現量無顯著增加，但暴露於 ZnO 會導致 SOD 和 MT 的表現量顯著上升。HSP70 在所有實驗測試中都增加了兩倍到四倍，表示除了氧化的緊迫之外，可能還有其他形式的緊迫來源，如細胞損傷。

## 參考資料:

Hund-Rinke K, Simon M (2006) Ecotoxic effect of photocatalytic active nanoparticles (TiO<sub>2</sub>) on algae and daphnids. Environ Sci Pollut R 13:225–232