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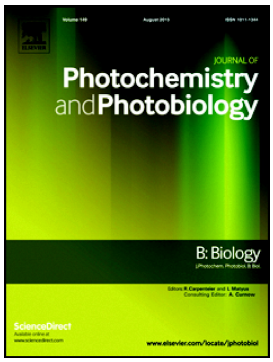

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Gerardo Pulido-Reyes, Esperanza Martín, J.L. Gu. Coronado, Francisco Leganes, Roberto Rosal, Francisca Fernández-Piñas

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Physicochemical and biological interactions between cerium oxide nanoparticles and a 1,8-naphthalimide derivative

Gerardo Pulido-Reyes[a]*, Esperanza Martín[b], J. L. Gu. Coronado[b], Francisco Leganes[a], Roberto Rosal[c], Francisca Fernández-Piñas[a].

[a]Departamento de Biología, Facultad de Ciencias, Universidad Autónoma de Madrid, E-28049, Spain.
[b]Departamento de Química-Física Aplicada, Facultad de Ciencias, Universidad Autónoma de Madrid, E-28049, Spain.
[c]Departamento de Ingeniería Química, Universidad de Alcalá, E-28871, Alcalá de Henares, Madrid, Spain.

Abstract

Cerium (Ce) oxide nanoparticles (CNPs) have attracted attention due to their high bioactivity and unique redox-chemistry. The oxygen vacancies at the surface of the nanoparticle explain the autocatalytic properties of CNPs in which the Ce^{3+} atoms occupy the center of the oxygen vacancies surrounded by Ce^{4+} atoms. Until now, CNPs have been associated with organic molecules at the synthesis stage to extend their applications or improve their stability. However, there is a lack of information regarding the post-synthesis interaction of CNPs and organic molecules that could enhance or induce new properties. Due to their unique optical properties and their many uses in different areas such as supramolecular chemistry or biomedicine, we have chosen a derivative from the family of naphthalimides (the 4-amino-1,8-naphthalimide-N-substituted; ANN) to study the interaction with different CNPs (CNP1-4) and their joint bioactivity compared to that of the same compounds alone. ANN-CNP complexes were formed as revealed by spectroscopic studies, but, the interaction was markedly different depending on the physicochemical properties of CNPs and their surface content of Ce^{3+} sites. The ANN adsorption on all CNPs involved the amino group in the naphthalene moiety as shown by NMR spectroscopy, while the pyrrolidine ring was mainly involved in the specific interaction between ANN and CNP1. The biological effect of each CNP and ANN individually and forming complexes was assessed using a bioluminescent model bacterium. The results showed that ANN and CNP with the higher content of surface Ce^{3+} (CNP1) when combined acted additively towards the used model organism. In the opposite, ANN-CNP2, ANN-CNP3 and ANN-CNP4 complexes were antagonistic when the nanoparticles dominated the mixture. The results of this study contribute to expand the knowledge of the interaction between nanoparticles and organic molecules which may be useful for understanding the behavior of nanoparticles in complex matrices.

Keywords: cerium oxide nanoparticles, 1,8-naphthalimide, adsorption, bioactivity, mixture toxicity

*Corresponding author: gerardo.pulido@uam.es. Full postal address: Departamento de Biología, Facultad de Ciencias, Universidad Autónoma de Madrid, E-28049, Spain.