Assessing the detection limits of multi-isotopically labelled CdSe/ZnS quantum dots in natural and biological environments

N. IZYAN SUPIANDI.[1]*, Y. SIVRY[1]*, G. CHARRON[2], M. THARAUD[1], J.-M. GUIGNER[3], M.F. BENEDETTI[1]

[1]Institut de Physique du Globe de Paris (IPGP), 75005 Paris, France (*correspondence : sivry@ipgp.fr)

[2]Laboratoire Matière et Systèmes Complexes (MSC), Univ. Paris Diderot, 75013 Paris, France

[3]Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie (IMPMC), 75005 Paris, France

The vast majorities of nanoparticles (NPs)-related studies presented in the literature are carried out in conditions far from those in real environmental [1] or biological media. In particular, the high concentrations (>1 mg/L) of NPs used in experimental studies are related to the difficulty of detecting nanoparticles in complex and "noisy" environments. However, changes in NPs concentration can affect its physicochemical behavior (ex: solubility, aggregation) and thus the final interpretation and understanding of results.

In order to overcome analytical barriers while working at representative realistic concentration, innovative tools such as HR-ICP-MS and non-traditional stable isotopes (isotopically modified NPs [2] or "spiked") have been used. 7 nm sized isotopically labelled quantum dots (QDs), CdSe/ZnS core-shell structure were synthesized, enriched in ^{68}Zn, ^{77}Se and ^{111}Cd. These multi-spiked QDs were disseminated at very low concentrations (from 0.1 ng/L to 5 μg/L) in both aquatic and biological matrices and then analyzed by HR-ICP-MS (ThermoScientific Element II) based on a protocol adapted from Dybowska et al. [3]. Our results allow to assess the detection and quantification limits of spiked QDs in complex matrices such as river water, seawater, saliva, urine, plasma or growth media. The feasibility of isotopic labeling at very low concentrations has been demonstrated: spiked Zn, Cd and Se issued from QDs were quantifiable at 1, 0.3 and 20 ng/L respectively in a media not containing the same natural elements. In contrast, these limits hardly reach 1000, 15 and 1000 ng/L in saliva, and 50 and 30 ng/L for spiked Zn and Cd respectively in seawater, and 50 and 0.3 ng/L respectively in Seine river water. The results obtained in this experimental work are applicable for studying QDs fate and behavior in most aquatic and biological media.

[1] Gottschalk F. et al. (2009). ES&T, **43**, (24), 9216-9222.
[2] Sivry Y. et al. (2011). ES&T, **45**, (15), 6247-6253.
[3] Dybowska et al. (2011). Env. Pollution, **159**, 266-273.