Session: Nanobiology, Nanomaterials, Safer by design Nanomaterials

Keywords: Nanoparticles, Nanotoxicology, Environmental applications and implications, Bio-surface, DNA.

Title: Reproductive toxicity of combusted diesel additive nano-ceria on mammalian cells

Autors: Martina Cotena[1,2] Melanie Auffan[2], Virginie Tassistro[1], Elena Siri[1,3], Jerôme Rose[2], and Jeanne Perrin[1,3].

Affiliations: (1) Faculty of Medecine, Aix Marseille Université, Equipe Biomarqueurs, Environnement, Santé - Institut Méditerranéen de Biodiversité et d'Ecologie UMR 7263, IRD 237; (2) CEREGE, Aix-Marseille Université, CNRS, IRD, Collège de France, INRA, Aix-en-Provence, France (3): AP-HM La Conception, Centre Clinico-Biologique d'Assistance Médicale à la Procréation - CECOS, 13385 Marseille Cedex 5, France.

Abstract

Cerium dioxide nanoparticles (CeO_2NPs) are used in diesel additives to reduce particulate emission matter and decrease fuel consumption. CeO_2NPs could be released from diesel engine in the environment as a result of the combustion of diesel fuel. During combustion, the physico-chemical properties change (size, shape) and affect the behaviour in aqueous media (kinetics of dissolution, aggregation state) highlighting the need of a better understanding on their toxic potential at each stage of the nanomaterial life cycle. Their potential reproductive toxicity is poorly investigated even if gametes are the only cells able to transfer onto the offspring their DNA mutations.

The aim of the study is to analyse the genotoxic impact of combusted CeO_2NPs on mature male and female rat germ cells using very low concentrations. Alkaline comet assay showed a statistically significant increase in DNA damage in rat spermatozoa, oocytes and follicular cells exposed *in vitro* to the lowest 0,001 $mg.l^{-1}$ and the highest concentration tested (1 $mg.L^{-1}$) of combusted CeO_2 NPs. The analysis of chemical (un)stability of combusted CeO_2NPs in FertiCult^{TM} medium using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) showed that the concentration of dissolved Ce were below the detection limits (<0.0002µg/L).

Since, the genotoxicity observed is inversely proportional to the concentrations [0.001 to 1 $mg.l^{-1}$], we might hypothesize that our results depend on the different aggregation states. At the highest concentrations, CeO_2NPs could easily form aggregates reducing the possible interaction with cells, while at low concentrations aggregation should be reduced, allowing thus a higher interaction with cells.

Session (Safer by Design Nanomaterials in collaboration with Labex Serenade
Keywords: nanomaterials, exposure, consumer, environment, case study

A Safer by Design approach on exposure to nanomaterials: seven case studies of the LabEx SERENADE project

C. de Garidel-Thoron[1,2], A. Masion[1,2], M. Auffan[1,2], S. Pekar[1,2], J-Y. Bottero [1,2], J. Rose[1,2] and the LabEx SERENADE Consortium[1]

1. LabEx SERENADE consortium, Europole de l'Arbois, 13545 Aix –en-Provence, France ; Aix-Marseille University, CNRS, CEA, INSERM, INERIS, INRA, IRD, Grenoble Alpes University, Montpellier University, University Paris-Est-Creteil, Novancia Business School, Allios, Suez-environnement
2. CEREGE CNRS, Aix-Marseille University, CNRS, IRD, INRA, Coll France, Aix en Provence, France

Abstract

Nanomaterials are expected to be a key to innovation breakthroughs and to lead to many new applications by 2020 and further. To reach the forecasted level of economical development, the public acceptance of nanotechnology is essential not only in terms of human health safety but also concerning the environmental impact. This lead manufacturers to develop sustainable processes of production, taking account safety and acceptance considerations since first steps of the design and during the entire production of new-generation nanomaterials.

The LabEX (Laboratory of Excellence) SERENADE (funded since 2012 by the French "Investissements d'Avenir" project) proposes an integrated scientific and educational approach to develop new concepts and tools for the Safer Design of next generation Nanomaterials and manufacturing processes. It is supported by a French national multi-disciplinary network of 11 academic partners including most of the French pioneering groups in the field from fundamental to applied research and education and 2 industrial partners (Suez-Environment, ALLIOS).

SERENADE initiated seven integrated case studies aiming at testing the SERENADE "Safer by Design" methodology on various product types (photocatalytic paints, sunscreen, quantum dots, silver nanowire, food packaging) and examining the often neglected end of life stage. We present the approach and the first results of the case studies with a specific focus on the determination of consumer and environmental exposure.

Session: Session Safer by Design Nanomaterials
Keywords: Nanoclays; Palygorskite; Spiramycin; Adsorption;

Removal of spiramycin from aqueous solutions using the nanoclays of natural and purified Algerian palygorskite

Lala Setti Belaroui[1, 2], Abderrahman Habibi[2], Alberto Lopez Galindo[3], Aránzazu Peña[3]

1. Department of Pharmacy, Faculty of Medicine, University Oran 1 Ahmed Ben Bella, BP 1510 Oran, El M'Naouer, Oran (Algeria).
2. Laboratory of Chemistry of Materials (LCM), Faculty of Applied and Exact Sciences, University Oran 1 Ahmed Ben Bella, BP 1524 Oran, El M'Naouer, Oran (Algeria).
3. Instituto Andaluz de Ciencias de la Tierra (CSIC-University of Granada), Avda. de las Palmeras, 4, 18100 Armilla, Granada (Spain).

Natural (Sif Pal) and purified palygorskites (Pur Pal) were used for studying the adsorption of an antibiotic (spiramycin) worldwide consumed. Both palygorskites have been characterized by infrared spectroscopy, X-ray fluorescence analysis, X-ray diffraction, N_2-BET and electron microscopy (TEM) (Belaroui et al., 2014 ; Ouali et al., 2015). The average mineralogical formula of Pur Pal is as follows: $(Si_{7.88}Al_{0.12})\ O_{20}\ (Mg_{1.69}\ Al_{1.71}\ Fe_{0.43})\ (OH)_2\ (K_{0.06}\ Ca_{0.05}\ Na_{0.15})\ (OH_2)_4.4H_2O$ (Belaroui et al., 2018). An adsorption study was carried out to evaluate the potential of these palygorskites to retain spiramycin from polluted water. Different parameters were evaluated such as the mass of the clay, the effect of pH or the concentration of spiramycin in solution. The concentration of spiramycin was determined by ultraviolet spectrophotometry. Kinetic and adsorption experimental data were fitted to different models.

The removal efficiency of spiramycin was higher with Pur Pal (89.2%) than with Sif Pal (73.6%). The adsorption kinetics of the antibiotic was better fitted to a pseudo-second order model. Regarding the adsorption process, the Langmuir and Temkin equations explained better than Freundlich the adsorption of spiramycin on Sif and Pur Pal, with a maximum adsorption capacity of 10.2 mg g^{-1} for Pur Pal, doubling that of Sif Pal (Figure 1). The Algerian palygorskite could be used as a cheap alternative for the removal of spiramycin from wastewater.

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11, 12 & 13 septembre
Session: Safer by design
Keywords: Nanomaterials; Composite; Pillared compound; Adsorption; Depollution.

Nanocomposite made of pillared clays for depollution of pharmaceutical wastewater

Naïma RACHID[1], Karima HAMDI ALAOUI[2], Corinne CHANEAC[1], Jérôme LABILLE[2], Clément LEVARD[2], Florence BENOIT[1], Isabelle BAUDIN[3], Amélie GUILLON[3], Muhammad BIN NORHARIZAM[3], Mohamed BIZI[4].

1. Sorbonne Université, CNRS, Laboratoire de Chimie de la Matière Condensée de Paris, UMR 7574, Paris, France
2. CEREGE, CNRS, Aix-Marseille Université, Aix en Provence, France
3. SUEZ, CIRSEE, Le Pecq, France
4. BRGM, Orléans, France

The growing use of antibiotics induce the emergence of micropolluants in the environment, especially in water. To overcome this problem, we focused our work on the synthesis of nanocomposites materials to test the adsorption capacities of five targeted substances that are the doxycyclin, the carbamazepin, the ciprofloxacin, the danofloxacin and the sulfaméthoxazol. Nanocomposites consist in a pillared clay structure. Pillaring is a process used to expanded property in increasing porosity and reactivity of the material. Pillared clays are prepared by intercalation of metal oxides nanoparticles between the layers of a montmorillonite (as shown in figure 1). Two materials were prepared, first silica nanoparticles were intercalated between the clay sheets (Several particles size of silica are experimented and studied by granulometry) and second, an heterogeneous nucleation of iron cation using microwave assisted thermal treatment was performed in presence of clay. Morphologies of the nanocomposites were characterized by SEM-edx and TEM. The adsorption capacity of micropollutants was investigated by adsorption isotherms experiments using UV spectroscopy in different water. These results were compared to the treatments with activated carbon powder.

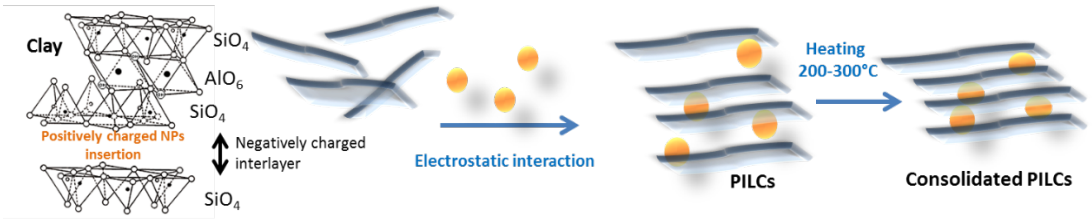

Figure 1: Schematic representation of the synthesis of nanocomposites