# Behavior and fate of ITER-like tungsten nanoparticles potentially released into freshwater ecosystems during tokamak reactor operation and maintenance.

Amazigh Ouaksel[1], Andrea Carboni[1,2], Danielle Slomberg[1], Vladimir Vidal[1], Olivier Proux[3,4], Catherine Santaella[5], Lenka Brousset[6], Bernard Angeletti[1], Alain Thiery[6], Jérome Rose[1], and Mélanie Auffan[1]

[1] *Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement (CEREGE) – Aix Marseille Univ – Europôle Méditerranéen de l'Arbois - Avenue Louis Philibert - BP 80 - 13545 Aix-en-Provence cedex 4, France*
[2] *Universita degli Studi di Sassari, Italie*
[3] *European Synchrotron Radiation Facility (ESRF), 6 rue Jules Horowitz BP220 38043 GRENOBLE CEDEX, France*
[4] *Observatoire des Sciences de l'Univers de Grenoble (Fédération OSUG-CNRS), 122 rue de la piscine, 38400 Saint Martin d'Héres, France*
[5] *Laboratoire d'Ecologie Microbienne de la Rhizosphère et d'Environnements extrêmes (LEMIRE) – UMR7265, CEA, CNRS, Aix-Marseille Université - Centre de Cadarache, 13108 Saint-Paul les Durance Cedex, France*
[6] *Institut méditerranéen de biodiversité et d´écologie marine et continentale (IMBE) – UMR7263- Aix-Marseille Université, Avignon Université, CNRS, IRD, France*

ouaksel@cerege.fr

Tungsten (W) is intended as a plasma-facing component in thermonuclear experimental tokamak reactors (ITER). Post plasma-W interactions, submicron tungsten particles can be released. This study investigated the exposure of lentic freshwater ecosystems to ITER-like tungsten nanoparticles in indoor aquatic mesocosms. Monitoring included tungsten (bio)distribution, (bio)transformation, speciation, and impacts following a relevant exposure scenario (chronic, medium-term, low-dose contamination). Additionally, mechanistic studies using a combination of microfluidics and X-ray Absorption Spectroscopy (XAS) provided a time-resolved understanding of tungsten's oxidative dissolution in freshwater. Following contamination, tungsten persisted in the water column (over 90%), showing significant (~40%) and rapid (< 7 days) oxidation-dissolution and polymerization. This led to significant exposure of planktonic niches, strong affinity of polymerized tungsten for aquatic vegetation, and potential transfer to higher trophic levels like aquatic snails. Over five weeks, the bio-physicochemical parameters of the mesocosms remained stable, and no acute impacts were observed on micro- and macro-organisms. These findings offer key insights into the environmental behavior, fate, speciation, and impacts of ITER-like tungsten nanoparticles, and valuable data for hazard and risk management strategies.

*Références :*

*Journal of Hazardous Materials, Volume 465, 5 March 2024, Page 133093*