Environmentally Persistent Free Radicals Associated with Nanoparticles: the LSU Superfund Research Center Investigates an Emerging Pollutant

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Srp Superfund Research Program

Hazardous substances at Superfund sites are frequently associated with particulate matter (PM), either in contaminated soils or sediments, emissions from treatment facilities, or dust from remediation or containment activities. Our research focuses on newly-identified pollutant-particle systems, including *environmentally persistent free radicals*, that may form from the combination of pollutants and particulate matter, and their effect on respiratory and cardiac health. The ultimate goal of the research is to protect human health by providing information to be used in risk-based decisions on treatment options for Superfund wastes. The existence of EPFRs could lead to a paradigm shift for evaluating the toxicity of as chemisorbed EPFR-particle pollutant systems.

Our findings on the generation and toxicity of nanoparticles indicate that the development and use of nanotechnologies requires careful consideration of the environmental and health impacts of the materials and techniques.

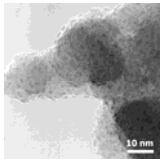
It's not just about research: training, communication and community engagement

The **Training Core** provides an infrastructure and environment that promotes the development of post- doctoral and graduate students in the highly interdisciplinary field of health effects engineering science.

The **Research Translation Core** is responsible for communicating research findings to a variety of audiences, including the general public, health and environmental professionals, regulatory agencies, businesses, and other researchers.

The goal of the **Community Outreach Core** is to work with residents of selected communities close to Superfund sites and to create a structure for communication between community stakeholders and researchers with the LSU Superfund Center.

Investigating the chemistry of EPFRs



Formation and Reactions of Environmentally Persistent Free Radicals in Thermal Processing of Superfund Wastes (Project 1) explores the origin and fate of EPFRs in thermal treatment devices by identifying the mechanisms of EPFR formation and stabilization on transition metal surfaces and determining the role of iron oxide-containing, combustion-generated particles in the formation of PCDD/F from chlorobenzenes and chlorophenols.

Environmentally Persistent Free Radicals in Contaminated Soils (Project 3) investigates the formation of EPFRs within PCP-contaminated soils.

Structure and Properties of Metal Oxide Particle-Adsorbate Systems (Project 6) characterizes the metal nanoparticles, structurally and electronically; and determines the surface processes and interactions of CHCs that lead to the formation of persistent free radicals and other toxic pollutants.

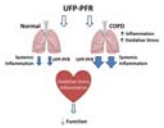
The **Materials Core** provides samples of Superfund-related particles and surrogates to the research projects.

The **Computational Core** supports the work of the Center by calculating the properties and reactivities of models for metal oxide ultrafine particles (UFPs) and fine particles (FPs). Ab initio calculations are used to study the structures and spin states of neutral iron oxide clusters, FenOn and FenOn+1 (n=1-2).

Research highlights:

Research findings suggest that the stability of the radical is related with the reducibility of the metal or their ability to accept electron and suggests that the persistency of environmentally free radicals (EPFRs) is dependent on their internal reaction with the metal oxide surface and not their reactivity toward molecular oxygen. An understanding of the mechanism by which PCDD/Fs and EPFRs are formed in thermal treatment of hazardous substances can be used to minimize formation and emissions of these compounds through combustion modification, including thermal quenching the cool-zone as well as avoidance of combinations of catalytic metals and potential precursors.

Investigating the health effects of EPFRs



Environmentally Persistent Free Radicals Alter Pulmonary Immunologic Homeostasis(Project 2) seeks to establish the mechanism by which exposure to PM from Superfund sites modulates pulmonary immune homeostasis and results in the development of asthma.

Environmentally Persistent Free Radicals Increase Cardiac Vulnerability to Ischemia(Project 4) investigates the effect of EPFRs on cardiac health.

Pollutant-Particle Systems and Xenobiotic Bioactivation (Project 5) examines the roles of the P450 and HO-1 systems in the response to EPFR exposure within an organism.

The **Oxidative Stress Core** supports the non-biomedical and biomedical projects investigators in identifying the role of radical-particle systems in generating reactive oxygen species and inducing oxidative stress.

Research highlights:

Studies demonstrate that human airway epithelial cells exposed to EPFRs undergo epithelial-to-mesenchymal transitions (EMTs), including loss of epithelial cell morphology, decreased E-cadherin expression and increased α-smooth muscle actin (α-SMA) and collagen I production. These data suggest that EPFR-induced EMT plays a significant role in airway dysfunction and may provide an explanation for epidemiological evidence supporting PM exposure and increased risk of asthma. These results were published in the American Journal of Respiratory Cell and Molecular Biology.

Recent publications by the LSU Superfund Research Center team

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