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Unregulated nanoparticles from diesel engines inhibit lungs

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(PhysOrg.com) -- Diesel engines emit countless carbon nanoparticles into the air, slipping through government regulation and vehicle filters. A new University of Michigan simulation shows that these nanoparticles can get trapped in the lungs and inhibit the function of a fluid that facilitates breathing.

Lung surfactant is a fluid containing protein and lipid molecules. It reduces surface tension in the lungs, prevents them from collapsing and helps transport foreign particles that will ultimately be expelled from the lungs.

Inhaled carbon nanoparticles, however, appear to behave differently than most foreign particles. Computer simulations indicated that they wouldn't be expelled, but would become trapped in the surfactant, entangled with fatty lipid molecules that wrapped their tails around the nanoparticles and into their central cavities.

"The presence of the nanoparticle can hinder the function of lung surfactant by affecting the interaction between the lipids and peptides," said Angela Violi, assistant professor in the U-M College of Engineering. A peptide is a piece of a protein. Violi was scheduled to present her findings during her invited talk at the American Chemical Society meeting Aug. 20.

This is believed to be the first time researchers have demonstrated how these nanoparticles can get caught in the lungs and affect the behavior of surfactant. Other studies have shown that buildup of nanoparticles in the lungs can lead to inflammation, blood clotting and changes in breathing and heart rates.

"There is mounting evidence that very small particles have a greater negative impact on health than larger particles," Violi said. "Nanoparticles emitted by diesel engines and other combustion sources are a health concern because of both their size and the carcinogens with which they are associated. This problem is exacerbated by the fact that there is currently no effective regulatory control of these nanoparticles."

Current U.S. and European diesel emissions regulations address particle sizes of 2.5 microns or larger. (A micron is one-thousandth of a millimeter.) That's still up to three orders of magnitude larger than the nanoparticles Violi studies. Carbon nanoparticles make up only 0.1 to 1.5 percent of the total mass of particles diesel engines emit, but in terms of the number of particles, nanos compose between 35 percent and 97 percent of the emissions, depending on the traffic.

The computer model Violi created to run this simulation can also predict how various combustible materials will burn, what nanoparticles will be created, how those particles will be shaped and how they could affect the lungs. This tool could be useful in predicting biofuel emissions, Violi says.

"It could help us reach the goal of engineering biofuel molecules to reduce emissions," Violi said. It's conceivable that engineers could genetically modify plants to produce cleaner burning fuels, she said. Violi will also discuss these applications in her American Chemical Society talk.

Violi is an assistant professor in the departments of Mechanical Engineering, Chemical Engineering and Biomedical Engineering.

The presentation at the Chemical Society's meeting in Philadelphia is called "Lipid membrane uptake of carbonaceous nanoparticles from combustion sources." A related paper on this research titled "Molecular Dynamics Simulation Study of a Pulmonary Surfactant Film Interacting with a Carbonaceous Nanoparticle" will be published in the Oct.15 issue of *Biophysical Journal.*

Provided by University of Michigan