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# Peas in a Pod? The Similarities between UFPs and Nanoparticles Yield Research Opportunities

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https://doi.org/10.1289/EHP2097

From a size standpoint, engineered nanoparticles are identical to ultrafine particles (UFPs) in ambient air—both measure 100 nm or less in diameter—but differences in the origin and potential chemistry of the two groups of particles have sent investigators down separate paths of inquiry. In a new workshop report in *EHP*, researchers outline knowledge-sharing opportunities that may help bolster understanding of both types of particles.[1]

"We realized that a lot of the work in ultrafine particles could be fed back into nanotoxicology, and vice versa," says first author Vicki Stone, a toxicologist at Heriot Watt University in Edinburgh. "So we brought some of the field together to discuss these opportunities."

Initial studies on the negative health effects of particulate air pollution focused on coarse particles measuring 2.5–10 µm in diameter ($PM_{2.5–10}$) and fine particles measuring 2.5 µm or less in diameter ($PM_{2.5}$). It was not until the 1990s that animal studies revealed that even tinier particles can cause potentially harmful inflammatory responses.[2] These UFPs can be inhaled deep into the lungs, where their large surface area gives them more opportunity to damage the alveoli.[3]

"For negative health outcomes, they really give you more bang for your buck," says Terry Gordon, an environmental health scientist at New York University. Gordon was not involved with the new report.

Studies on ambient UFPs have largely relied on substances such as carbon black, titanium dioxide, and diesel soot. The problem, says Steffen Loft, an environmental health scientist at the University of Copenhagen, is that it is difficult to tell exactly what particles and particle combinations are causing problems. "There are lots of data on the effects of air pollution exposure, but these ultrafine particles are not as well characterized. It is hard to say this particle has this effect," Loft says.

In the past decade, the field of nanotoxicology has taken off, and researchers have begun to develop new ways of characterizing nanomaterials and the ways in which they may exert their toxic effects. Used in everything from antimicrobial coatings on fabrics to sunscreens, engineered nanoparticles have raised a new set of health questions for exposed workers and consumers.

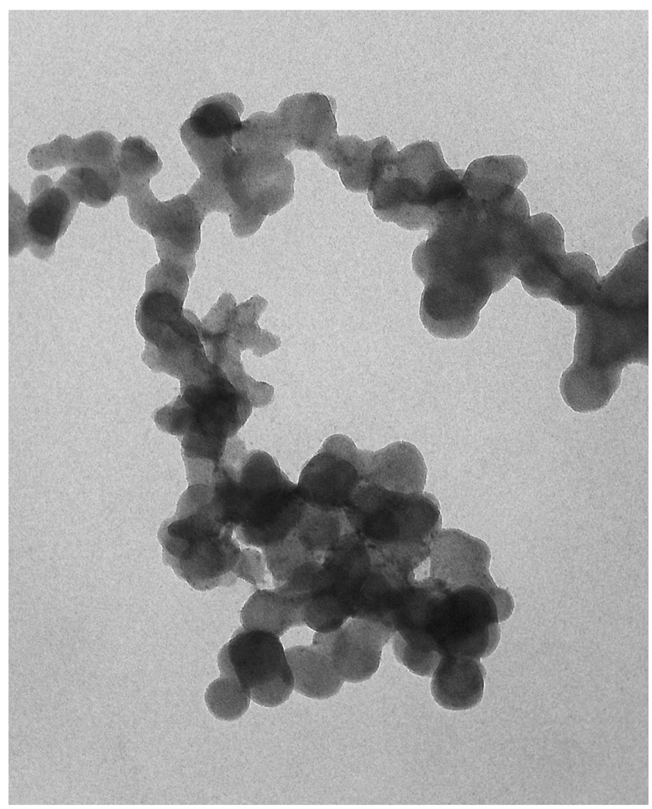
Unlike ambient UFPs, which comprise a hodgepodge of chemicals created from combustion reactions, scientists know the exact makeup of engineered nanoparticles. Their use requires precise knowledge of their size and chemistry, which makes it easier to study any negative health outcomes.[1]

The relatively recent emergence of these particles, however, means that scientists know less about the extent and potential health effects of exposures, Stone says. This is worrisome, she says, because the potential for exposure to engineered nanoparticles is significant—almost everyone uses at least one product containing some type of nanoparticle on a daily basis.

Awareness of the knowledge gaps in the complementary areas of UFPs and engineered nanoparticles resulted in a 2015 meeting of top researchers in the field. The meeting was part of the European Union's MODENA COST Initiative to coordinate interdisciplinary collaboration in nantoxicology. Out of that conference emerged the new report, which identified research priorities and key lessons that could be applied to this area. The lessons included broad overarching goals in applying research from UFPs to nanoparticles and vice versa. They also homed in on specific experimental strategies to elucidate the specific physiochemical effects of different particles and the ways in which toxicity is influenced by underlying chemistry.[1]

There are no regulations that specifically address ambient UFPs, although their size lumps them into the range covered by $PM_{2.5}$ rules.[4] The lack of targeted regulations, combined with shrinking research budgets, make it ever more challenging to study the health effects of UFPs and nanoparticles, Gordon says.

As a result, knowledge-sharing efforts like those proposed in the report will be crucial to working to protect human health from the negative effects of air pollution. "These efforts are a



UFPs (such as this sample, which came from wood smoke) can be inhaled deep into the lungs, where their large surface area gives them more opportunity to damage the alveoli. Unlike engineered nanoparticles, UFPs in any given sample can vary widely in their chemical makeup, making it difficult to tell exactly what particles and particle combinations may cause problems. Image: © Anette Kocbach Bølling.

good way to positively affect funding and get better data by promoting more efficient and better focused research," Loft says.

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## References


1. Stone V, Miller MR, Clift MJ, Elder A, Mills NL, Møller P, et al. 2017. Nanomaterials versus ambient ultrafine particles: an opportunity to exchange toxicology knowledge. Environ Health Perspect 125(10):106002, PMID: 27814243, https://doi.org/10.1289/EHP424.
2. Seaton A, Godden D, MacNee W, Donaldson K. 1995. Particulate air pollution and acute health effects. Lancet 345(8943):176–178, PMID: 7741860, https://doi.org/10.1016/S0140-6736(95)90173-6.
3. Sager TM, Castranova V. 2009. Surface area of particle administered versus mass in determining the pulmonary toxicity of ultrafine and fine carbon black: comparison to ultrafine titanium dioxide. Part Fibre Toxicol 6(1):15, PMID: 19413904, https://doi.org/10.1186/1743-8977-6-15.
4. Kumar P, Morawska L, Birmili W, Paasonen P, Hu M, Kulmala M, et al. 2014. Ultrafine particles in cities. Environ Int 66:1–10, PMID: 24503484, https://doi.org/10.1016/j.envint.2014.01.013.