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Contact: brent@iit.edu

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1.http://europa.eu/legislation_summaries/consumers/consumer_information/l21253_en.htm

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Ultra-fine particles emitted by commercial desktop 3D printers

Desktop three-dimensional (3D) printers, available for use in offices and homes, can release between 20 and 200 billion ultra-fine particles (UFPs) per minute, finds new research. UFPs may pose a risk to health, and the study's authors recommend caution when operating 3D printers inside unventilated or unfiltered indoor environments.

The advent of low-cost commercial desktop 3D printers, used to turn computer based designs into physical objects, has seen 3D printing move out of research laboratories and industrial applications into the home and office. Most desktop 3D printers work by feeding a solid plastic polymer into a computer-driven heated nozzle through a process called 'fused deposition modeling' (FDM), that lays down material in layers.

The nozzle deposits a thin layer of molten polymer on a surface. As the plastic hardens, the next layer is added, slowly building a solid 3D object. Two plastic polymers are commonly used for this: acrylonitrile butadiene styrene (ABS) or polylactic acid (PLA). ABS requires higher nozzle temperatures (220 °C) than the biodegradable form of PLA (180 °C).

Similar industrial processes have been shown to emit relatively high levels of gases, volatile organic compounds and fine particles. Nano-sized UFPs — particles smaller than 100 nanometres (nm) — may be of particular importance to health.

Most desktop 3D printers lack filter or ventilation accessories and are likely to be used in enclosed spaces, such as offices, with little additional ventilation. To date there has been no research on the UFP emissions of these printers.

The new study measured UFP emissions from FDM desktop 3D printers in a commercial office space. The researchers took UFP measurements in an enclosed office with two printers using PLA and two identical printers using ABS, each operating for about 20 minutes. They analysed the data and compared it to other domestic sources of UFPs. The estimated emission rates for both PLA and ABS were high, with PLA emitting around 20 billion particles per minute, and 200 billion particles per minute for ABS.

Compared to other domestic sources of UFPs, the 3D printing using PLA had a similar UFP emission to cooking using an electric frying pan. Using ABS resulted in UFP emissions similar to those from grilling food on a gas or electric stove at low power.

UFPs are able to deposit in the lungs and airways of the head, where they can travel through the olfactory nerve to the brain, and studies have shown that UFPs may be an important part of the toxicity emitted from melting plastics. A number of studies have also shown that high UFP concentrations, such as from traffic pollution, are associated with adverse health effects, such as asthma, stroke and even decreased lifespan due to heart and lung diseases.

The authors highlight that the chemical identity of the UFP itself is likely to be important with regards to safety. For example, while ABS has been shown to have toxic effects, PLA is considered safer, and PLA nanoparticles are widely used in drug delivery. They note a couple of limitations in their methodology. Firstly, they did not determine the chemical composition of the UFPs. This is important because small amounts of ABS and PLA can be broken down into other types of chemicals with different or unknown health risks when heated. Secondly, the effects of particles sticking together or growing by condensation were not accounted for, which could affect measurements.

While the actual risk to health remains unclear and further research is needed, on the balance of the evidence, the researchers conclude that because of the large emission of UFPs by 3D printing instruments, users should be cautious when operating them inside unventilated or unfiltered indoor environments. Under the General Product Safety Directive[1] manufacturers have a responsibility to provide consumers with information to assess a product's threat — especially when not obvious — and to take necessary measures to avoid such threats. In the case of 3D printers this could be by providing enclosed and filtered printers or ventilation equipment.