Effect of Combustion Particle Size on Pathologically Important Responses in Lung Cells

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Although combustion-derived particulate matter(cdPM) is a significant contributor to fine and ultrafine PM levels, our understanding of its health effects is complicated by cdPM's complex nature: a dynamic mixture of particles and condensed material with different sizes, shapes, and chemical compositions that is generated from a range of sources. Furthermore, several confounding factors make comparing results from various studies of PM's adverse effects difficult including, for cdPM, fuel composition, the age of the combustion device, combustion conditions, lubricants, and sampling methods. For example, experimental and epidemiological studies about the effect of various PM size fractions (PM_{10}, $PM_{2.5}$, and PM_1) provide somewhat conflicting results. As particle size diameter decreases, its relative surface area increases, which in turn increases the bioavailability of atoms or molecules and may lead to increased pro-inflammatory effects. This study focuses on directly testing the effect of cdPM size on biological responses in lung cells.

cdPM with consistent properties is generated from a premixed flat-flame burner combusting a jet-fuel surrogate at an equivalence ratio of 2.5. A nitrogen shroud and a glass housing minimize atmospheric effects. cdPM consistency is verified by examining the particle size distribution and cdPM composition. The sample is then diluted, thermally denuded and directly collected in DI water by using an impinger. The cdPM sample is size segregated by a flow field flow fractionation (FlFFF) into four size ranges (with particle diameter (nm) less than 100, 100-150, 150-200 and 200-300). The different size fractions are studied for their effect on cell viability, cellular uptake, inflammatory response, cytochrome P450 (CYP) 1 A1 mRNA induction. The biological outcomes are evaluated in A 549 human alveolar basal epithelial cells and in THP-1 cells, a pro-monocytic cell line that is differentiated to pulmonary macrophage-like cells. These results are a step towards understanding some of the interactions between the links between combustion particle physicochemical properties and health effects.