A Cost-effective, Miniature Electrical Ultrafine Particle Sizer (mini- eUPS) for UFP Monitoring Network

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1. Experimental setup for the performance comparison between SMPS and mini- eUPS using lab-generated aerosol particles

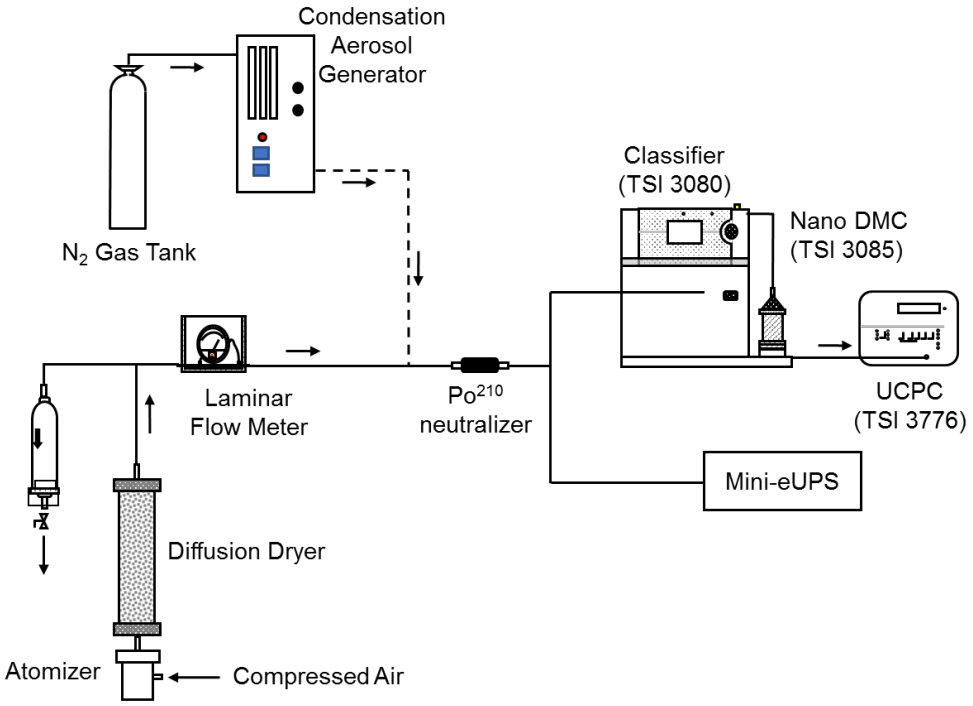

Figure S1. Experimental setup for the generation of laboratory particles.

Figure S1 is the schematic diagram of the experimental setup for the generation of test particles in the laboratory for the performance comparison of the mini- eUPS and TSI SMPS (TSI scanning mobility particle sizer). Two particle generators were included in the setup: a custom-made Collison atomizer and a condensation monodisperse aerosol generator (CMAG, TSI, Model 3475). For generating unimodal particles, only the atomizer was used to spray NaCl solutions in 0.1% volume concentration. Generated particle stream was passed through a diffusion dryer to remove the solvent in generated droplets, resulting in polydisperse particles in the unimodal size distribution (i.e., CMD = 40±5nm, σ = 1.7). For the generation of bimodal-distributed particles, the CMAG was used to generate particles with the peak size at 150nm (σ = 1.2) in addition to the application of atomizer. Nitrogen was applied in CMAG as the carrier gas and NaCl particles were produced as the nuclei particles. Particles in high concentration were obtained after the condensation of diethylhexyl sebacate (DEHS) vapor on nuclei particles. Particles in a bimodal size distribution were obtained by mixing particles generated from both generators, (i.e., wich the peak sizes of 40 and 150 nm). Electrical charges on generated particles

were minimized by a bipolar charger with Po^{210} radioactive source prior to the testing. Resultant particle stream was sampled and measured by both mini- eUPS and SMPS at the same time. The SMPS used in this part of the experiment included a neutralizer (TSI Model 3077), a long DMA (TSI Model 3081) and a UCPC (TSI Model 3076). The ratio of aerosol to sheath flow rate for the DMA was set at 1:10.

2. Experimental setup for measuring diesel particles by both mini- eUPS and SMPS

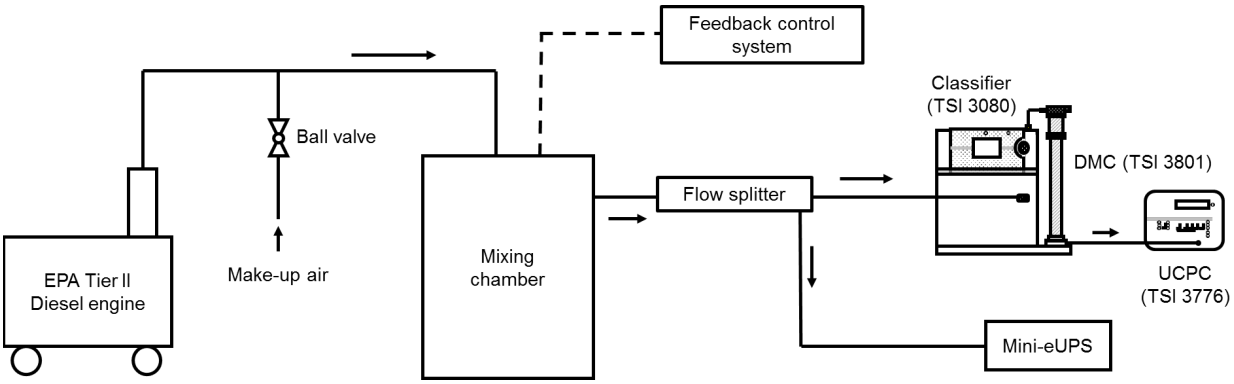

Figure S2. Experimental setup for measuring diesel particles by mini-eUPS and SMPS.

The schematic diagram shown in Fig. S2 gives the experimental setup for the measurement of diesel particles by mini- eUPS and TSI SMPS. An EPA Tier 2 diesel engine (Cummins Onan quiet diesel 8KW max Genset, Model 8HDKAK11451J) was used in the setup to generate diesel particles to be characterized. Upon the sampling, the concentration of produced diesel particles was diluted by a makeup clean air to control the particle number concentration in the mixing chamber. A feedback control (by Labview) was applied to control the flowrate of makeup air. A flow splitter was connected to the outlet of mixing chamber for measuring diluted particles by both both mini- eUPS and TSI SMPS at the same time.

3. Setup for particulate emission from a 3D printer:

Shown in Figure S3 is the experimental setup for measuring the particle emission from a low-cost 3D (Lulzbot mini, Aleph Objects Inc.) printer by both TSI SMPS and mini-eUPS. A

conductive PLA filament (Protoplant Inc.) was fed into the extruder at 230 °C. The melted paste was then extruded onto the printing plate. The printer was resided in a chamber (AirClean 2000 workstation), whose dimensions are 40'' (100 cm, L) × 24'' (60 cm, W) × 20'' (50 cm, H). A small tube was installed close to the extrusion nozzle for particle sampling. The sampled particle stream was split into two for the measurement by TSI SMPS and mini-eUPS. The TSI SMPS was composed of a neutralizer (TSI Model 3088), a long DMA (TSI Model 3081) and a UCPC (TSI Model 3076). The aerosol-to-sheath flow rate ratio of the DMA was set at 1:10.

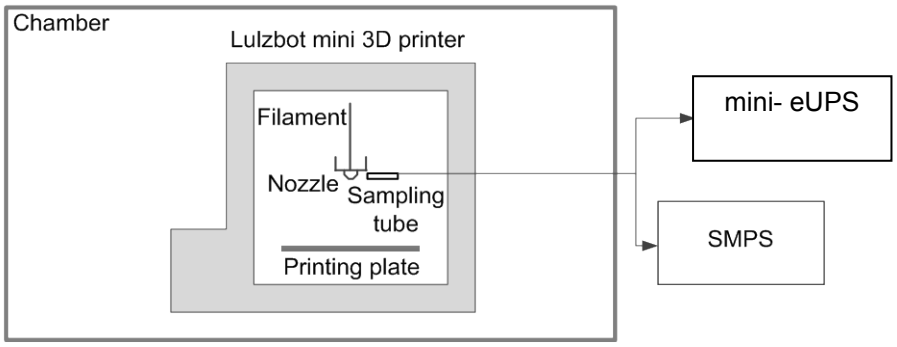

Figure S3. Setup for measuring particle emission from the extrusion mode of a 3D printer by SMPS and mini- eUPS.