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MINIATURE, PORTABLE DEVICE FOR MEASURING EXPOSURE TO AIRBORNE NANOPARTICLES

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Technology Description

Engineers in Prof. Daren Chen's laboratory have developed a patented portable device for sampling and measuring nanoaerosols for industrial hygiene and aerosol science applications. Currently, a variety of industrial applications require the chemical synthesis of submicron and nanometer-sized particles which could be toxic, presenting a health risk to workers who are exposed to those nanoaerosols. However, conventional monitoring instruments are too large to monitor personal exposure of nanoparticles as an individual moves around the workspace. This invention solves that problem with a miniature nanoparticle sizing instrument that can perform ambient particulate sampling and measurement to track and record the person's daily and hourly exposure over a wide space. It utilizes electrical mobility-based measurement which is better suited than traditional inertial techniques for separating particles in the submicron and nanometer ranges (10 – 200nm). This device could be widely deployed to detect exposure to ultrafine airborne nanoparticles for epidemiological research or occupational health monitoring.

Stage of Research

- The inventors have built and tested a **prototype device with three components**: a unipolar aerosol mini charger (to generate charged ions); a quarter-sized disk electrostatic aerosol classifier (an electrostatic precipitator that characterizes the size of submicron particles by sorting their electrical mobilities); and a sensitive aerosol electrometer (for detection of small currents).
- In **tests of the mini charger component**, the inventors demonstrated intrinsic and extrinsic charging efficiency for particles ranging from 10-200 nm in diameter: 100% charging efficiency at 20 nm for a 0.3 lpm flow rate and at 45 nm for a 1.5 lpm flow rate.
- In **tests of the aerosol classifier component**, the inventors demonstrated that the classifier can differentiate particle sizes by electrical mobility under different operational conditions: at aerosol and sheath flow rates of 0.5 and 1.0 lpm there was 67% particle penetration at 10nm.

Applications

- **Occupational health monitoring –** portable device to measure personal workplace exposure to airborne nanoparticles in the in 10-200 nm range
- **Research instrument –** to monitor exposure for epidemiological studies

Key Advantages

- **Miniaturized for personal use:**
  - portable, compact design enables the instrument to collect aerosol samples as a person

moves around the work environment
    - prototype components include a mini-charger that is 1 inch length and 0.5 inch diameter and a classifier disk that is quarter-size
    - low voltage operation
- **High performance**
    - mini-charger demonstrates very good aerosol charging intrinsic and extrinsic efficiency for particles ranging in size from submicron to 10nm
    - mini-classifier disk retains performance for penetration of charged nanoparticles in disk and collection (ensures that all charged particles are trapped when they pass through the filter)
    - two independent control chambers in the mini-classifier for optimizing mobility sorting characteristics
- **Lower manufacturing cost –** simple construction
- **Sensitive to small current measurements –** electrometer measures direct current measurement (unlike conventional aerosol electrometers which measure induced electrical current) for fast response to small current measurement

Patent

- Miniaturized ultrafine particle sizer and monitor (U.S. Patent No. 8,044,350)

Publications

- Li, L., Chen, D. R., Qi, C., & Kulkarni, P. S. (2009). A miniature disk electrostatic aerosol classifier (mini-disk EAC) for personal nanoparticle sizers. *Journal of Aerosol Science*, 40(11), 982-992.
- Qi, C., Chen, D. R., & Greenberg, P. (2008). Performance study of a unipolar aerosol mini-charger for a personal nanoparticle sizer. *Journal of Aerosol Science*, 39(5), 450-459.