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Aerosol Laboratory

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Abstract

Submicron- and nano-particles suspended in a gas or air form an aerosol. Aerosol particles are involved with many practical problems such as environmental pollution, contamination in microelectronics and pharmaceutical cleanrooms, pulmonary edema and carcinogenicity, and applications such as aerosolized drug delivery. The major aim of this project is to acquire instruments to enhance education programs and research capabilities in aerosols science and technology. The acquired equipment is the major contributor to the Aerosol Laboratory. It substantially enhances the laboratory's scope of experimental capability.

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Introduction

The size of particles has a major influence on their properties. Particles with aerodynamic diameter range from 7 nm to 15 μm are involved in many practical problems. Non-invasive drug delivery using aerosolized therapeutic particles are required to administer through inhalation method. On the contrary, particles are often released into the environment from emission sources such as hazardous waste incinerators, welding systems, automobiles, engine and aircraft exhausts. The generation with controlled bioengineered properties, characterization using aerodynamic and electrostatic principles, and quantitative determination of lungs' flow, suspension and deposition require a series of invitro experiments.

This project is acquiring items of equipment that comprise a system of aerosolized submicron- and nano-particle generating, characterizing, and analyzing tools. Acquired instruments can enhance aerosol education and research. Jackson State University has just established a new program in Bioengineering. The students can have opportunities to experience these instruments. Its contribution can be substantive in enhancing other science, technology, engineering, and math (STEM) programs as well. These instruments can open the learning and experimental opportunities to undertake experimental studies in submicron and nano sized aerosol generation, control, and protection.

Equipment

The aerosol science and technology is a multidisciplinary area of research as depicted in Figure 1. The Aerosol Laboratory can be a catalyst for integrating and focusing individual research efforts of various departments. The acquired instruments are: Flow-Focusing Monodisperse Aerosol Generator (FMAG) (Figure 2a), Scanning Mobility Particle Spectrometer (SMPS)(Figure 2b), Aerodynamic Particle Sizer (APS) (Figur 2c), Optical Particle Sizer (OPS) (Figure 2d), Aerosol Neutralizer (radioactive aerosol neutralizer), Advanced Aerosol Neutralizer (nonradioactive aerosol neutralizer), Vacuum Pump, Aerosol Electrometer, Flow Calibrator, Q-Trak Indoor Air Quality Monitor, Bipolar Charge Analyzer, High Volume Air Samplers PM10 and PM2.5, Multi-gas Combustion Analyzer, B2 Biosafety Cabinet, and workstation.

FMAG is an aerosol generator for producing monodisperse nano and submicron aerosol particles [1]. OPS measures particle number and mass concentration. SMPS spectrometer system consists of an

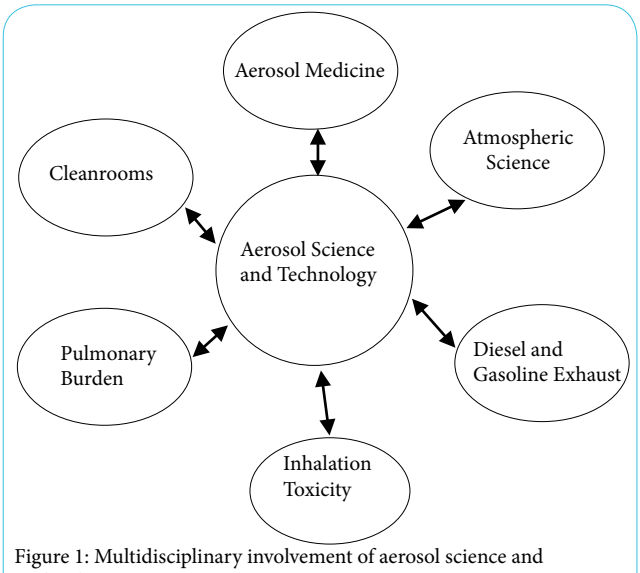

Figure 1: Multidisciplinary involvement of aerosol science and Technology.

electrostatic classifier to sort particles based on their electrical mobility and a condensation particle counter (CPC) to count the sorted particles [2]. CPC require an external vacuum source. Vacuum Pump is used to draw aerosols from a source to the sink. SMPS (1.0nm to 1.0 μm) and APS (0.5 μm to 20.0 μm) simultaneously measure size distributions (with mobility and aerodynamic particle diameters), light scattering intensity, and concentration. The Aerosol Electrometer provides accurate measurements of electrical current and flow rate. It measures total net charge on aerosol particles from 0.002 to 5 μm. The Aerosol Neutralizar and Advanced Aerosol Neutralizer can provide a neutralized aerosol particle charge and increase measurement efficiency [3]. Flow Calibrator is essential accessories for condensation particle counter. It is ideal for measuring inlet flows on CPC. The

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Figure 2: (a) FMAG, (b) SMPS, (c) APS, (d) OPS.

Q-TRAK Indoor Air Quality Monitor measures real-time indoor air quality e.g., temperature, relative humidity, organic and inorganic contaminants. The Bipolar Charge Analyzer measures the electrostatic bipolar charge distributions and classifications of aerosolized particles in real-time. The High Volume Air Sampler collects total particulate matters from the ambient in real time. These PM10 and PM2.5 high volume air samplers use mass flow controllers to maintain a constant flow rate during the sample. The Multi-gas Combustion Analyzer measures O_2, CO, NO, NO_2, and SO_2 contents of breathing air. The workstation is for storing and analyzing hundreds of experimental run aerosol data. The B2 Biosafety Cabinet is to build a working platform for experimental setup of these instruments in order to acquire hazardless operational space while handling biohazardous chemical and biological agents.

Research and Education Activities

The research areas encompassing aerosol science will facilitate the development of a new course, Aerosol Science and Technology. Graduate students will be able to undertake thesis/dissertation in combustion, inhalation toxicology, environmental and drug delivery science disciplines. Undergraduate students from Engineering, Biology, Chemistry, and Technology can also have opportunities to use these instrumentation. The instruments can provide faculty members from various departments and programs with high-quality state-of-the-art tools for aerosol related research.

Summary

These instrument can open the learning and experimental opportunities to conduct many studies. An aerosol is a colloidal system of solid or liquid particles in a gas. Aerosol science and technology covers generation, analysis, measurement, characterization, and removal of aerosols, effects of aerosols on the human health, workplace, and environment, application of aerosols, and a wide variety of other topics. With laboratory experiments, students will receive practical training on skills to sample, measure, and characterize aerosols in a variety of applications. Students will have the opportunity to gain a fundamental understanding of aerosol properties and behavior.

Competing Interests

The authors declare that they have no competing interests.

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References

1. Duan H, Romay FJ, Li C, Naqwi A, Deng W, et al. (2016) Generation of Monodisperse Aerosols by Combining Aerodynamic Flow-Focusing and Mechanical Perturbation. Aerosol Science and Technology 50: 17-25.
2. Application Note CPC-003 (US) (2014) Fundamentals of Condensation Particle Counters (CPC) and Scanning Mobility Particle Sizer (SMPS) Spectrometers, CPC-003-US, TSI Incorporated.
3. Lee HM, Soo Kim C, Shimada M, Okuyama K (2005) Bipolar Diffusion Charging for Aerosol Nanoparticle Measurement Using a Soft Xray Charger. Journal of Aerosol Science 36: 813-829.