LUND UNIVERSITY | LTH FACULTY OF ENGINEERING

Suggested master degree work within the LTH Profile Area Aerosols 2024

Department of Design Sciences

Degree Project in Aerosol Technology, MAMM05, 30 credits

Toxicity screening of particles in real time – laboratory evaluation of novel instrument

Contact person: Aneta Wierzbicka, aneta.wierzbicka@design.lth.se

Project description: Reactive oxygen species (ROS) are a group of free radicals which can be either present on the surface of particles or generated through chemical reactions between particles and cells. Exposure to particle induced ROS is believed to be the main toxicity mechanism responsible for the adverse health effects associated with inhalation of airborne particles. Current legislation uses particle mass concentration as a metric, but there is a need for a more health-relevant metric that captures the potential toxicity of the particles. Assessment of ROS has the potential of becoming such a new metric and provides an interesting alternative for pre-screening of particle toxicity. In the Aerosol Laboratory we have built an instrument which can assess ROS on particles in real time (time resolution in minutes) which is a huge advantage in comparison to off-line methods. The thesis work will include laboratory experiments to assess the performance of the newly built instrument and tests on different

sources of particles (e.g., secondary organic aerosols, particles from electronic cigarettes, cooking, candles).

Exhaled aerosol sampler for respiratory infection diagnostics

Contact person: Malin Alsved, malin.alsved@design.lth.se
Project description: During the covid-19 pandemic, several superspreading events took place during choir singing. We investigated the exhaled aerosol during singing and it showed that vocalization produces much more aerosol droplets than breathing. This, in combination with an upper respiratory infection (covid-19) that has not yet given rise to any symptoms in the individual, can explain the reason for high transmission during singing and loud talking. This project aims to build a physical simulation of human vocal folds and make them vibrate to generate aerosol droplets. With this vocal chords simulator we can generate more aerosol droplets than with humans and we can also evaluate the effects of liquid properties on aerosol generation. Project suitable for someone who wants to combine physics with anatomy and some crafty building skills.

Microphysics of exhaled droplets

Contact person: Malin Alsved, malin.alsved@design.lth.se
Project description: Aerosols droplets are formed in our respiratory systems when we breathe and speak, and upon exhalation the water evaporates, leaving a dry solid particle. A large proportion of viruses in these aerosol droplets are inactivated during the drying process, but those that are still infectious in the dry particle often remain infectious for a long time. This project is focused on understanding the microphysics of these complex droplets that contain salts, proteins, lipids, and potentially microorganisms, using microscopy and spectroscopic methods. Thus, it will be a cross-disciplinary project including both laboratory work and theory, with a high degree of freedom and creativity.

Department of Physics

Constructing an Optical Tweezer Raman Microscopy system for applications in studying single nanopollutants

Contact person: Kim Cuong Le, thi_kim_cuong.le@fysik.lu.se
Project description: Nano pollutants have gained increasing attention for their potential environmental and health impacts. Among them, black carbon, originating from incomplete combustion processes, poses a significant threat. These ultrafine particles not only contribute to climate change by absorbing sunlight, but also contaminate the air, water, and soil, with detrimental effects on both ecosystems and human health. Raman spectroscopy (RS) is a powerful technique widely employed for structural characterization. However, it typically necessitates thick samples to obtain discernible Raman signals while mitigating interference from substrates. This poses a challenge, particularly for environmental pollutants with low concentrations. Our aim is to facilitate the study of individual nanopollutants by advancing the use of Optical Tweezer Surface Enhanced Raman Spectroscopy. Optical tweezers enable the manipulation of single particles, while SERS shows promise due to its substantial enhancement of inelastic light scattering by molecules, with factors of up to 10^8 or greater.
Requirements: The master's thesis work will encompass the initial phase of the project, which involves constructing an Optical Tweezer Raman Microscopy system. The student is expected to possess a foundational understanding of lasers, optics, and programming. A strong willingness to delve into topics of personal choice and interest is essential.

Constructing a spectrometer for remote sensing pollutants

Contact person: Kim Cuong Le, thi_kim_cuong.le@fysik.lu.se
Project description: The emission of carbonaceous aerosols, such as black carbon, into the atmosphere has significant adverse impacts on both global climate and human health. While many techniques and instruments have been developed to measure the size and

concentration of these aerosols, it remains crucial to continue advancing methods for quantitatively measuring and characterizing their emissions. We have recently designed and acquired all the necessary equipment to construct a Scheimpflug Raman lidar for ranging carbonaceous aerosols. This project builds upon the work of a previous master's thesis, Design of a hyperspectral Scheimpflug Raman lidar for ranging of aerosolized soot | LUP Student Papers done by Oskar Öjstedt. I am looking for a master student who should have a background in lasers and optics and be familiar with MATLAB. If you are not yet experienced with professional optical design software such as Zemax or CAD software like SolidWorks, this project offers an excellent opportunity to gain hands-on experience with these tools. This is an experimental project so you will spend most your time in the lab.
Requirements: The student is expected to possess a foundational understanding of lasers, optics, and programming. A strong willingness to delve into topics of personal choice and interest is essential. Because of the innovation and complication of the project, a half-pace is preferred so the student can work during two semesters.

Engineering aerosols – Investigating the properties of multi-element nanoparticles

***Contact person*:** Linnéa Jönsson, linnea.jonsson@ftf.lth.se
***Project description*:** Due to their tunable and remarkable properties, nanoparticles have found applications in areas such as catalysis, sensing, and medical diagnostics.
Spark ablation is a method that can produce engineered nanoparticles in the aerosol phase, thereby eliminating the need for additional processing steps to clean the particles like in the case of conventional chemical production. This method is also advantageous since one can produce nanoparticles made of more than one material, which typically leads to better properties (e.g., increased catalytic selectivity, more sensitive sensing) compared to single-element particles.
This project will involve the use of spark ablation to create multi-element nanoparticles and then analyze their properties by

investigating their size, shape, and composition using techniques such as a differential mobility analyzer (DMA), a scanning or transmission electron microscope (SEM or TEM), X-ray energy dispersive spectroscopy (XEDS) and inductively coupled plasma mass spectroscopy (ICP-MS).
The work will be done in close collaboration with me, Linnéa, and the engineering nano-aerosol group at Solid State Physics, led by Prof. Maria E. Messing and Prof. Knut Deppert.
Link to our group: https://www.nano.lu.se/research/materials-manufacturing/nanoparticle-synthesis-and-assembly