Carleton UNIVERSITY
Canada's Capital University

Prof. M Reza Kholghy
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Directed Study on Micro- and Nanoparticle Technology (MNP) FS2020

Course Description: Introduction to fundamentals of micro- and nanoparticle synthesis and processing, their applications and environmental impact. Sampling of nanoparticle and measuring techniques to characterise their size distribution and morphology. Modeling of nucleation, agglomeration, surface growth and optical properties of particles. Combustion made nanoparticles as functional materials and pollutants. Atmospheric Aerosols. Particles as renewable energy carriers.

Course Organizer: Prof. M. Reza Kholghy,
Guest Lecturers: Dr. Prem Lobo (Team Leader at NRC)
Dr. Fengshan Liu (Senior Research Officer at NRC)
Prof. Amir Hakami (Professor at Carleton University)
Prof. Jeffrey Bergthorson (Professor at McGill University)

Time, place: Thursdays, 15.35 – 17.25, Live Lectures on Zoom

Fundamentals

08.09. Introduction, Class Projects, Particle Size Distributions (Prof. Kholghy)
17.09. Continuum & Free Molecular Regimes, Particle Diffusion (Prof. Kholghy)
Coaching Proposal Writing
Exercise on Particle Size Distribution due
24.02. Brownian Coagulation (Prof. Kholghy)
Exercise on Diffusion due
Two Page Proposals due
01.10. Shear Coagulation, Sintering, Agg(reg/lomer)ates (Prof. Kholghy)
Exercise on Coagulation I due
08.10. Critical Size - Condensation Surface Growth – Nucleation (Prof. Kholghy)
Exercise on Coagulation II due
15.10. Aerosol Particle Characterization (Prof. Kholghy)
Exercise on Critical Size and Nucleation due

Practical Applications

22.10. Absorption and Scattering of Light by Nanoparticles (Dr. Liu)
05.11. Optical Diagnostics (Dr. Liu)
Coaching Oral Presentations & Report Writing
12.11. Atmospheric Aerosols and Pollutant Transport (Prof. Hakami)
19.11. Black Carbon Emissions from Aviation & Marine Engines (Dr. Lobo)
26.11. Combustion Synthesis of Materials (Prof. Kholghy)
03.12. Metal Particles as Renewable Energy Carriers (Prof. Bergthorson)
10.12. **Student Oral Presentations**
24.12. *(no lectures)* ***10-page reports of projets due***

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- **Grading:**

- Exercises, 5 points each (25 points)
- Written proposal in AIChE journal style, 2 pages (15 points), expected work: 15 hours
- Laboratory or theoretical study, expected work: 35 hours
- Oral presentation (10 points), expected preparation: 4 hours
- Final report, 10 pages (50 points), expected work: 16 hours

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References:

1. Aerosol Technology, W. Hinds, Wiley, 2nd Edition, 1982 or 1999.
2. Smoke, Dust and Haze, S.K. Friedlander, Oxford, 2nd edition, (1977) & 2000

Mini-projects are a critical review of the literature or a theoretical or an experimental project **related** to the topics of the lecture.

Aim of the Mini Projects: "Hands-on" particle technology, Application of lecture topics, Introduction to research, Training of project planning & thesis writing, Training of oral presentations (95% of decision are made on oral arguments! Effective speaking is a MUST)

Two-page proposals should answer the following questions by reviewing and citing at least 10 references

a. Why is this topic important?
b. What has been done already?
c. What will be done by the student?

Ten-page Reports should "educate" a reader with general engineering background on the theory of the subject and should effectively document the methods used and results and suggest future work so that another student can easily build on the existing work.

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Micro- and Nanoparticle Technology Mini-Projects FS2020
(E: experimental, T: theoretical, L: literature study)

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1. (T) **Simple relations for nanoparticle collision rate** **AVAIL.**

The collision rate of nanoparticles is an important parameter for nanoparticle synthesis and pollution control, and it depends on their morphology. Here different collision rates suggested in the literature will be compared to collision rates obtained from detailed simulations to assess their accuracy.

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2. (T) **Nanoparticle light scattering and absorption: Revision of textbook theories** **AVAIL.**

The light scattering and absorption of flame-made nanoparticles are typically approximated by the Mie theory for spheres or by the more accurate Rayleigh-Debye-Gans theory for fractal-like clusters of spherical monomers (primary particles). The latter is revised here to account for the multiple light scattering simulated by discrete element modeling.

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3. (L) **Measuring Optical Properties of Soot Deposited on Films** **AVAIL.**

Impactors are often used for size selecting and sampling of soot nanoparticles. There soot particles of different size are collected on thin aluminum films. This work investigates how optical properties of such particles can be measured.

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