MIE 1706: Manufacturing of Cellular and Microcellular Polymers (2021S)

Instructor: Prof. Chul B. Park RS210 978-3053 park@mie.utoronto.ca
Lecture Hours: M 9 am - 11 am (Zoom) **and** F 9 am - 11 am (Zoom). See the detailed lecture schedules below. There is no lecture on Feb 22, 2020.
Final Exam: Mar 12th, 2021 (most likely 3-hour open-book/take-home exam)

References

1. A set of technical papers from the webpage http://mpml.mie.utoronto.ca/lab/Publications/publications.html (account: mpml and password: cbpweb)

2. Course notes: http://www.mie.utoronto.ca/courses/mie1706/ (user: mie1706 and password: polymers1706)

Grading scheme:	Reading Assignment:	17 marks (1 mark for each paper)
	Take-home Exam:	12 marks (to be issued on Feb 8th, 2021, due on Feb 12th, 2021)
	Term Project:	20 marks (5 marks for the mid-term report due on Feb 5th, 2021 and 15 marks for the final report due on Mar 8th, 2021)
	Final Exam:	51 marks (Mar 12th, 2021)

Contents

1. Introduction and Thermo-Physical Properties of Polymer/Gas Mixtures
    - Introduction to Foams and Foam Structure
    - Foaming Agents
    - Pressure - specific Volume - Temperature (PVT)
    - Surface Tension
    - Solubility
2. Cell Nucleation and Growth
    - Cell Nucleation - Homogeneous and Heterogeneous
    - Cell Growth, Cell Stability, and Simultaneous Modeling of Cell Nucleation and Growth
    - Visualization of Foaming
3. Foam Extrusion
    - Control of Cell Nucleation
    - Control of Cell Growth
4. Foam Injection Molding
    - Low-Pressure Foam Injection Molding (Structural Foam Molding)
    - High-Pressure Foam Injection Molding
    - MuCell Technology
5. Bead/Particle Foaming
    - EPP (Effect of Crystal on Foaming)
    - EPLA
6. Foam Compression Molding
    - Crosslinking and Foaming
    - Crystallization and Foaming
7. Open-Cell Foaming

Lecture Contents and Reading Assignments

Day	Date	Lecture Contents	(Reading) Assignments
M	01/04	1.1 Introduction to Foams and Foam Structure	Draw v_f vs size
F	01/08	1.2 Foaming Agents, (PVT and) Solubility	J123
M	01/11	1.2 Foaming Agents, (PVT and) Solubility	J216
F	01/15	2.1 Cell Nucleation - Homogeneous and Heterogeneous	J211
M	01/18	2.2 Cell Growth, Cell Stability	J144
F	01/22	2.3 Simultaneous Modeling of Cell Nucleation & Growth	J086
M	01/25	2.4 Visualization of Foaming	J191
F	01/29	3.1 Foam Extrusion: Control of Cell Nucleation	J052
M	02/01	3.2 Foam Extrusion: Control of Cell Growth	J060
F	02/05	3.2 Foam Extrusion: Control of Cell Growth. *Mid Term-Project Report due.*	J130
M	02/08	4.1 Foam Injection Molding: Low-Pressure Structural Foam Molding. *Take-home exam to be issued.*	J133
F	02/12	4.2 Foam Injection Molding: High-Pressure Foam Injection Molding. *Take-home exam due.*	J257
F	02/19	4.2 Foam Injection Molding: High-Pressure Foam Injection Molding	J285
F	02/26	5.1 Bead/Particle Foaming: EPP	J203
M	03/01	5.2 Bead/Particle Foaming: EPLA	J247
F	03/05	6.1 Foam Compression Molding	C314
M	03/08	7.1 Open Cell Foaming. *Final Term-Project Report due.*	J080
F	03/12	*Final Exam*	

INSTRUCTION FOR THE READING ASSIGNMENTS

- 1 page summary of the reading assignment due on the next lecture.
- Pay attention to the due date. Marks will be severely deducted for the late reports (20% for each day).
- The report will not be returned. Make your own copy before you submit it.
- Use the Times New Roman font, the font size 12, and single line spacing. 1 or 2 columns
- Type the report. Marks will be severely deducted for hand-written texts (except for the first homework).

INSTRUCTION FOR THE TERM PROJECT

1. Purpose

The purpose of the term project is to deeply understand the fundamentals of the foaming phenomena. You have to demonstrate that you have completely understood the cell nucleation theories, the equations used in the cell growth phenomena, and the coupled nature of the cell nucleation and growth phenomena, and the associated cell stability issue.

2. Topic

Any topic in the areas of cell nucleation, cell stability, cell coarsening, cell coalescence, cell growth, and simultaneous modeling of cell nucleation and growth, is acceptable. It does not have to have any unique and new contributions, but if you present any innovative ideas that do not violate the basic principles of the papers listed below, you will get some bonus mark. But please note that you need to first clearly demonstrate that you have fully understood the contents of these 8 papers. If you include the analysis of the cell nucleation phenomena in any of the actual foam processes such as foam extrusion, foam injection molding, bead foaming, or foam compression molding, it will be a feather in your cap. But again, too much emphasis on the application may not be impressive. I want to make sure that you fully understood the basic concepts. Warning: those who think that a part of these papers is wrong, and therefore develop a better theory or explanation of the phenomena, you had better first talk to me about your new concept. Most likely, you are wrong. If you do things on your own instead of demonstrating your understanding, your term-project mark may converge to zero.

Essential papers: J002, J086, J092, J144, J169, J190, J191, J205, J211 (note: The following statement in J205 "Furthermore, it is also hypothesized that the free volume within the amorphous regions was decreased due to polymer chain alignment under the applied ε, which caused a decrease in gas solubility." may be incorrect.)

3. Reports (20 marks)

- Interim report due on Feb 5, 2021. 2-page limit including the title and references. 2 column format (see the attached example). 5 marks.
- Final report due on Mar 8, 2021. 5-page limit including the title and references. 2 column format (see the attached example). 15 marks.
- Grading scheme

Technical contents:	70%
Communication skills:	30%

- Pay attention to the due date. Marks will be severely deducted for the late reports (20% for each day).
- I am attaching the Society of Plastics Engineers Annual Technical Conference paper template for your information. The Word file will be circulated to all.
- Make sure to include a formal bibliography at the end of the report.
- The report will not be returned. Make your own copy before you submit it.
- Use the Times New Roman font, the font size 10, and single line spacing. Please use the template format circulated by email.
- Type the report. Marks will be severely deducted for hand-written texts, figures, and tables. Equations, tables, and figures should be properly numbered. Proper captions should be attached to each table and figure.