MSE8803 Practical Polymer Characterization
(former MSE 6752)
Fall 2026
Syllabus

Class Time: T/Th 9:30—10:45 AM Molecular Science and Engineering (MoSE), #G021

Professor:	Vladimir Tsukruk vladimir@mse.gatech.edu	Office: MoSE 3100M Office Hours: Tuesdays, 2-3pm
Instructor:	Dr. Valeriia Poliukhova,	Office: MoSE 4243
TA:	Frank (H. C. Huang)	Office: MoSE 4243 huang.frank@gatech.edu

Description:
This special practice-oriented course aims on bringing fundamentals, useful knowledge and practical hints to first-year graduate students, which are critically important for successful utilization of major experimental techniques for polymer materials characterization. Topics to be covered include major experimental techniques for bulk, surface, and molecular characterization of polymer structures, morphologies, and polymer properties. The course includes an overview of advanced topics on polymer characterization ranging from chemical composition (UV, FTIR, Raman), structures/dimensions (DLS, SAXS, WAXS, TEM, SEM), and surface morphologies/composition (SEM, SPM, XPS, SE). In particular, special attention is paid to practical aspects of instrumentation, resolutions and limitations, data collection, and data analysis. Lectures will be complemented by instrument operation, sample preparation, and data analysis demonstration.

Requisite Knowledge Recommended: Permission of instructor. While there is no formal pre-requisite, students should have a basic knowledge of polymer science.

Modality: In-class lectures and practical experiences (lab touring, experimental videos, lab demonstrations). Lectures may be supplemented by "watch at home" videos or "watch-in-class" videos, but the goal is for dynamic exchange during lecture and practical competence in lab.

Electronic Delivery: CANVAS

Recommended Textbook:

D. Bukharina, P. Flouda, V. Tsukruk, *Polymer Characterization Microscopic, Spectroscopic, Thermal, Mechanical and Nanoscale Characterization*, De Gruyter, **2025**, ISBN: 978-3-11-134536-9

Lecture notes and practical videos will be provided as well as suggested bibliography for the various topics.

Course calendar

Date	Lecture	Topic	Comment
	1	**Course Introduction, Macromolecules, Composition, Properties prediction**	
	2	Structures, configuration, conformation	
	Lab tour	**MAC center**	VP/Frank, lab tour
	3	Transitions in polymers, colloids, composites	
	4	Spectroscopy 1: UV, IR and Raman spectroscopies	
	5	Spectroscopy 2: UV, IR and Raman spectroscopies	VP
	video	Lab demonstration: U-vis-NIR, FTIR, Raman	Frank, Yiming
	6	X-ray scattering: WAXS, SAXS, amorphous and crystalline polymers	VP
	7	X-ray diffuse, neutron, and light scatterings	VP
	8	Synchrotron, elastic and inelastic scattering	VP, **HW1: XR & Spectroscopy**
	Lab tour	**IMS: X-Ray & EM instruments**	VP
	9	Electron microscopies 1: TEM, HRTEM, STEM, SEM	
	10	Electron microscopies 2: SEM, ESEM, EDS, EDX	
	video	Lab demonstration: SEM, DLS	Frank, Yiming
		Exam 1: Scattering, Spectroscopy, & EM	Frank
	11	Mechanical properties: fundamentals and methods	
	12	Mechanical properties – viscoelastic behavior, dynamic	
	13	Thermal Analysis: TMA, DSC, TGA, DMA	
	14	Thermal Analysis: TMA, DSC, TGA, DMA	
		Spring Break	
	video	Lab demonstration: Static mechanics, DMA	Frank
	15	Scanning Probe Microscopy (SPM) 1: fundamentals	**HW2: EM&TMA**
	16	SPM 2: Imaging modes: FFM, NSOM, KPFM, EFM	
		Exam 2: Mechanics, Thermal, SPM1	Frank
	17	SPM 3: Probing modes: QNM, FDC, nano-DMA/IR	
	video	Lab demonstration: SPM modes	Frank
	18	Surfaces 1: XPS, ellipsometry, contact angle, tribology	
	19	Surfaces 2: XPS, ellipsometry, contact angle, tribology	**HW3: SPM&surfaces**
	video	Lab demonstration: ellipsometry, contact angle, review and discussion	Frank
	20	Summary, overview, final exam discussion, feedback	Reading period
		Final Exam, Comprehensive	

Grading: 30% Exams, 30% Homeworks, 15%- Quizzes, 25% Final Exam

Grading scale: A: 86 – 100%; B: 76 – 85%; C: 66 – 75%; D: ≤ 65%.

Course Expectations:

- Some assignments will come in the form of homeworks, integrated with lab activities.
- Midterm and final exams will be closed book unless otherwise indicated, relevant equations will be supplied. Any changes will be announced at least 5 days before the exam.
- We rely on various facilities across campus for lab touring.
- All assignments need to be completed in the time stated. Any late submissions (except where proper reasons are given) will result in reduced grade.

Course Outcomes. At the end of the course you will be able to:

1. Make predictions about critical polymer properties, often without calculator or internet access.
2. Learn to determine polymer macro and micro structure, as well as properties.
3. Identify which structure and properties are to be analyzed to evaluate the polymer.
4. Determine which techniques are most appropriate to determine the property of interest.
5. Understand how to prepare the sample and collect the data.
6. Understand the fundamental basis of the measurement technique.
7. Analyze the experimental data and determine/calculate the relevant properties.

Honor Code

We believe in the Georgia Tech Honor code: https://policies.gatech.edu/academic-affairs/academic-honor-code Students are urged to ask questions about what is permissible when it comes to working together on assignments and what is not, plagiarism, or other issues.

Wellness

We expect another semester in which challenges due to public health factors add to the normal stresses of academic life. We enjoy talking with students, so don't be shy about letting us know if you are feeling stressed. Remember GT's various resources for wellness, too: https://hw.gatech.edu/

Disabilities

We get it! If you qualify for an accommodation, be assured that we are eager to work with you.
https://disabilityservices.gatech.edu/