SCHOOL OF POLYMER SCIENCE AND POLYMER ENGINEERING

The University of Akron's College of Polymer Science and Polymer Engineering (CPSPE) was inaugurated in July of 1988 by combining the Department of Polymer Science, then in the Buchtel College of Arts and Sciences, with the Department of Polymer Engineering, then in the College of Engineering. Starting fall of 2020, the CPSPE was renamed the School of Polymer Science and Polymer Engineering (SPSPE). The school is organized for teaching and research at the graduate level, granting M.S. and Ph.D. degrees in either Polymer Science, or in Polymer Engineering (thesis required), and a Master of Polymer Science and Polymer Engineering (non-thesis option). In addition, the SPSPE offers a polymer minor program. The organization includes complementary research centers and facilities with instrumentation and support staff, which provides a research focus for faculty and graduate students. The program is one of the largest and broadest in the U.S., dating back to 1909, and is recognized as being among the world's best. Its traditional strengths in new polymer synthesis and their manufacturing processes which compound, shape, and assemble polymer products, have been complemented in the past two decades by computational simulations, morphological, surface and optical characterization, as well as a number of added specializations, such as new, federally funded programs in nanotechnologies, sustainability, biomimicry, energy generation, batteries and photonics that have permitted a much stronger focus on active polymer devices and assemblies. School of Polymer Science and Polymer Engineering faculty members have generated over 200 active patents and have licensed technologies that have been commercialized worldwide.

School Website (https://www.uakron.edu/cpspe/)

- Elastomer Science and Engineering, Certificate (https://bulletin.uakron.edu/graduate/colleges-programs/engineering/polymer-science-engineering/elastomer-science-engineering-certificate/)
- Master of Polymer Science and Polymer Engineering (https://bulletin.uakron.edu/graduate/colleges-programs/engineering/polymer-science-engineering/master-polymer-science-engineering/)
- Polymer Engineering, MSPE (https://bulletin.uakron.edu/graduate/colleges-programs/engineering/polymer-science-engineering/polymer-engineering-mspe/)
- Polymer Engineering, PhD (https://bulletin.uakron.edu/graduate/colleges-programs/engineering/polymer-science-engineering/polymer-engineering-phd/)
- Polymer Materials and Engineering at Beijing University of Chemical Technology, BE/ Polymer Science, MS (https://bulletin.uakron.edu/graduate/colleges-programs/engineering/polymer-science-engineering/polymer-science-materials-engineering-ms/)
- Polymer Materials and Engineering at Beijing University of Chemical Technology, BE/Polymer Engineering, MS (https://bulletin.uakron.edu/graduate/colleges-programs/engineering/polymer-science-engineering/polymer-materials-engineering-mspe/)
- Polymer Science, MS (https://bulletin.uakron.edu/graduate/colleges-programs/engineering/polymer-science-engineering/polymer-science-ms/)

- Polymer Science, PhD (https://bulletin.uakron.edu/graduate/colleges-programs/engineering/polymer-science-engineering/polymer-science-phd/)

Polymer Engineering (9841)

9841:525 Introduction to Blending and Compounding of Polymers (3 Credits)
Prerequisite: Permission of instructor. Nature of polymer blends and compounds and their applications. Preparation and technology using batch and continuous mixers. Mixing Mechanisms.

9841:527 Mold Design (3 Credits)
Prerequisite: permission of instructor. Molding methods to manufacture polymeric products. Machinery, materials, molds, equipment, computer-aided design.

9841:550 Engineering Properties of Polymers (3 Credits)
Prerequisite: permission of instructor. Introduction to engineering properties and polymer processing. Analyzing mechanical polymer tests in glassy, rubbery, and fluid states. Product design, rheology, rheometry, and polymer processing concepts.

9841:551 Polymer Engineering Laboratory (3 Credits)
Prerequisite: permission of instructor. Laboratory experiments on the rheological characterization of polymer melts, fabrication of engineering products, structural investigation of polymeric parts.

9841:600 Interfacial Phenomena in Soft Matter (3 Credits)
This course covers intermolecular interactions, (de)wetting, adsorption, adhesion and friction, colloidal stability, nucleation, and assembly process.

9841:601 Seminar in Polymer Engineering (1 Credit)
Presentations of recent research on topics in polymer engineering by internal and external speakers.

9841:610 Polymer Engineering Analysis (3 Credits)
Quantitative analysis methods central to Polymer Engineering, with applications including materials flow, deformation, and characterization.

9841:611 Fundamentals of Polymer Structure Characterization (3 Credits)

9841:621 Rheology of Polymer Fluids (3 Credits)

9841:622 Analysis & Design of Polymer Processing Operations I (3 Credits)
Prerequisite: 9841:621. Mathematical modeling and engineering design analysis of polymer processing operations including extruder screws, injection molds, dies, fibers, film formation.

9841:623 Analysis & Design of Polymer Processing Operations II (3 Credits)
Prerequisite: permission of instructor. Basic studies on non-isothermal phenomena in polymer engineering emphasizing crystallization, vitrification, frozen-in orientation and residual stresses, applications, including fiber spinning and film extrusion.
9841:631 Engineering Properties of Solid Polymers (2 Credits)
Transitions as a function of polymer structure, optical characteristics, mechanical including ultimate properties, viscoelastic behavior of elastomers and plastics, large strain behavior E emphasis on experimental methods.

9841:641 Polymer Chem & Thermodynamics (3 Credits)
Physico-chemical properties of amorphous and crystalline polymers. Glass transitions, crystallization, molecular orientation and morphology of important commercial polymers, fabricated products and composite materials.

9841:650 Introduction to Polymer Engineering (3 Credits)
Basic concepts of polymer engineering taught in lecture-laboratory format intended for orientation of new graduate students.

9841:651 Polymer Engineering Laboratory (3 Credits)
Prerequisite: 9841.622. Rheological characterization of polymer melts, rubber and plastic extrusion, extrudate swell, injection and compression molding, crystallization behavior, x-ray diffraction, film blowing, impact and tensile testing.

9841:661 Polymerization Reactor Engineering (3 Credits)
Polymerization kinetics, classical reactor design, comparison of polymerization in batch and continuous stirred tank reactors, flow patterns around agitators, tubular reactors, reactor stability.

9841:666 Research Methods (3 Credits)
This course will focus on providing guidance to beginning graduate students on general concepts that are typically encountered in research including: 1. Scientific method; 2. Ethics in research; 3. Scientific paper writing; 4 Scientific presentations.

9841:675 Carbon-Polymer Nanotechnology (3 Credits)
Prerequisite: permission of instructor. This course focuses on the fundamental aspects of nanotechnology in general and basic knowledge of polymer/carbon nanoscience and nanotechnology in particular.

9841:680 Polymer Coatings (3 Credits)
Prerequisite: permission of instructor. This course is an introduction to coating science. The synthesis of polymeric binders and pigments used in commodity coatings will be the focus of the first part of the course. The second part of the course will focus on coatings formulation and end-use applications for commodity coatings.

9841:699 Masters Thesis (1-6 Credits)
(May be repeated) Supervised original research in specific area of polymer engineering.

9841:712 Rheo-Optics of Polymers (2 Credits)
Applications of rheo-optical methods as means of determining stress fields in polymeric glasses and fluids during deformation, rheo-optical properties of polymers in glassy, rubbery and fluid states. Theory of dynamic birefringence and its application to mechanical relaxations of amorphous and semi-crystalline polymers, and recent experimental results.

9841:715 Advanced Characterization of Functional Polymers (3 Credits)
Prerequisites: 9841.611 and 9841.623 or equivalent (with permission of instructor). This course will focus on the advanced structural and functional property characterization techniques including optical, electrical, magnetic and others. A particular focus will be the influence of the history of polymer processing on these properties.

9841:720 Molecular Aspects of Polymer Rheology (2 Credits)
Prerequisite: 9841.621. Molecular theory for concentrated solutions and melts of flexible homopolymers, molecular rheology of miscible polymer blends, block copolymers, and liquid crystalline polymers.

9841:721 Rheology & Processing Two-Phase Polymer Systems (2 Credits)
Prerequisite: 9841.622 or equivalent. Particle-particle interactions, mixing devices and design, theoretical hydrodynamics of suspensions of rigid particles, experimental studies of rheological behavior, phenomenological theories representing suspension behavior, dispersion of droplets to form an emulsion, phase morphology development and rheological properties of blends.

9841:722 Advanced Modelling of Polymer Processing (2 Credits)
Prerequisite: permission of instructor. Modeling of processing operations including extrusion molding, fiber and film processing, computer-aided design.

9841:723 Rheology & Processing of Elastomers (2 Credits)
Interpretation of rheological properties and critical study and analysis of processing operations including behavior in internal mixers, screw extruders, die systems and vulcanization molding.

9841:724 Advanced Extrusion & Compounding (2 Credits)
Principles of operation and flow in single and twin screw extruders, screw design, characteristics of internal mixers, analysis and simulation of flow.

9841:725 Chemorheology & Processing of Thermosets (2 Credits)
Prerequisite: 9841.621 or 9841.622. Rheological behavior of thermosets, vulcanization of rubbers, time-temperature-transition relationships in thermosets, reaction injection molding, compression/transfer molding, pultrusion.

9841:727 Advanced Polymer Rheology (2 Credits)
Prerequisite: 9841.621 or equivalent. Second level course in non-linear constitutive equation for viscoelastic, viscoplastic, viscoelastic-plastic polymeric materials. Utility and applicability to polymer processing problems.

9841:728 Numerical Methods in Polymer Engineering (3 Credits)

9841:731 Stress Analysis of Polymers & Composites (2 Credits)
Prerequisite: 9841.631. The design of rubber mounts, bearings and sandwich components with demonstration of finite element methods. Classical plates and shells theories with applications to composite structures.

9841:745 Liquid Crystals (2 Credits)
Prerequisite: permission of instructor. Structure of low molecular weight and polymeric liquid crystals, characterization, physical properties including optical properties, phase transitions, structure-property relationships, processing of polymeric species.

9841:747 Polymer Colloids (3 Credits)
Prerequisite: permission of instructor. Colloidal dispersions, phase stability, aggregation structures, thermodynamics, kinetics of phase transitions in polymer colloids. Emulsion and solution polymerization, organic/inorganic hybrid materials, coating technology. Rheology of colloidal polymers.

9841:749 Phase Transitions in Polymer Blends and Alloys (3 Credits)
Prerequisite: permission of instructor. Elucidating thermodynamics of polymer blends, block copolymers, crystalline/liquid crystalline polymers, and kinetics of phase transitions. Structure development and modeling of reactive polymer blends.
9841:761 Injection and Compression Molding Fundamentals (2 Credits)
Prerequisite: permission of instructor. This course provides fundamental knowledge in physical, thermal and rheological properties required for injection and compression molding including theoretical and experimental aspects of various molding processes.

9841:770 Polymer Nanocomposites (3 Credits)
Prerequisite: permission of instructor. Develops understanding on synthesis, characterization, processing and properties of polymer nanocomposite materials involving nanoscale fillers in conjunction with thermosetting, thermoplastic, and elastomeric polymer matrices.

9841:773 Advanced Polymer Coating Technology (2 Credits)
Prerequisite: 9841:641 or equivalent. The polymeric binders used in radiation-curable coatings for electronic packaging and waterborne coatings will be stressed. The chemistry of dyes and the coatings science of pigments will be presented. The chemistry of polymer degradation will also be covered.

9841:777 Modeling of Nanoscale Materials (3 Credits)
Prerequisite: permission of instructor. Introduces molecular simulation methods (Monte Carlo, molecular dynamics) and their application to polymer-related materials at the molecular and coarse-grain levels.

9841:778 Advanced Functional Polymers (2 Credits)
Prerequisites: 9841:611 and 9841:641. This course focuses on the recent development of functional polymers for applications as advanced materials and smart devices, which requires the attendant to possess some prior knowledge of polymer science and polymer engineering from such 600 level course(s) as mentioned above.

9841:797 Advanced Topics in Polymer Engineering (2-3 Credits)
(May be repeated) Prerequisite: permission of instructor. Advanced special topics intended for Ph.D. students in polymer engineering.

9841:898 Preliminary Research (1-15 Credits)
(May be repeated) Prerequisites: completion of qualifying examination, approval of Student Advisory Committee. Preliminary investigation of Ph.D. dissertation subject.

9841:899 Doctoral Dissertation (1-15 Credits)
(May be repeated) Prerequisite: completion of candidacy examination of Student Advisory Committee. Original research by a Ph.D. candidate.

**Polymer Science (9871)**

9871:601 Polymer Chemistry (4 Credits)
Prerequisite: 3150:264 and 3150:314 or equivalent course or permission of instructor. Introduction to fundamentals and practical aspects of (co)polymer synthesis and reactions of polymers; use of polymerization kinetics and thermodynamics to understand polymerization mechanisms; structure-reactivity relationships.

9871:604 Special Projects in Polymer Science (1-3 Credits)
Prerequisite: permission. Research projects of limited nature assigned to student entering polymer science program. Intended to familiarize student with typical problems and techniques in this field.

9871:607 Seminar in Polymer Science I (1 Credit)
Prerequisite: limited to first-and second-year resident graduate students. Participants are to present a 25-minute lecture on some aspect of polymer science and to participate in discussions of lectures presented by other seminar participants.

9871:608 Seminar in Polymer Science II (1 Credit)
Prerequisite: limited to first-and second-year resident graduate students. Participants are to present a 25-minute lecture on some aspect of polymer science and to participate in discussions of lectures presented by other seminar participants.

9871:613 Polymer Science Laboratory (3 Credits)
Prerequisite or corequisite: 9871:601 or 9871:631 or 9871:674. Laboratory experiments focused on common techniques for polymer molecular characterization and characterization of polymer morphology, with a few polymer synthesis experiments.

9871:615 Laboratory Computer Applications in Polymer Science (3 Credits)
Prerequisites: Basic knowledge of computer programming and permission of instructor. Laboratory use of computers in polymer science research for data acquisition, data analysis, graphing, and preparation of reports and thesis.

9871:631 Polymer Physics I (4 Credits)
Prerequisites: 2 semester of undergraduate physics or permission of instructor. First half of an overview of polymer physics including the deal chain, chain in dilute solution, solution thermodynamics, polymer blends, and gels and networks.

9871:632 Polymer Physics II (4 Credits)
Prerequisite: 9871:631 or permission of instructor. Phenomenological description of viscoelasticity in polymers; molecular models for chain dynamics of solutions and melts; mechanical properties of polymers; polymer crystallization; electrical properties.

9871:674 Polymer Characterization (2 Credits)
Prerequisites: 2 semesters of undergraduate chemistry and 2 semesters of undergraduate physics and 9871:631 or permission of instructor. Principles of operation, strategies for experimentation design and concepts of data interpretation for most important characterization techniques applied in polymer science and engineering.

9871:685 Introduction to Macromolecules (2 Credits)
Prerequisites: 2 semesters of undergraduate chemistry or permission of instructor. Develops understanding of biomacromolecular structure and function, hierarchical self-assembly, functions of biological materials (e.g. silk, collagen) and principles for bio-inspired materials design.

9871:699 Master's Thesis (1-6 Credits)
Prerequisite: permission. For properly qualified candidate for master's degree. Supervised original research in polymer science, under direction of faculty member, followed by submission of thesis.

9871:701 Polymer Technology I (2 Credits)
Principles of compounding and testing, processing principles and types of operation, design principles.

9871:702 Polymer Technology II (2 Credits)
Prerequisite: 9871:701. Rubber industry, rubber compounding and processing, vulcanization methods, physical testing, plastics preparation and compounding, manufacturing processes. Lecture/laboratory.

9871:703 Polymer Technology III (2 Credits)
Prerequisite: 9871:702. Flow properties, extrusion, calendaring and milling, molding, mixing, bond operations, engineering properties, rubber springs, viscoelastic analysis design consideration. Lecture/laboratory.
9871:704 Condensation Polymerization (2 Credits)
Prerequisite: 3150:463 or 3150:563. Survey of the theory and practice of condensation polymerization. Numerous commercial examples are presented with special emphasis being placed on the properties and applications of polymers prepared by this technique. Structure-property relationships are highlighted for each major polymer class.

9871:705 Free Radical Reactions in Polymer Science (2 Credits)
Prerequisite: 3150:463 or 3150:563. Covers the kinetics and mechanisms of free radical initiated reactions encountered in polymer science, including polymerization methods, detailed considerations of the initiation, propagation and termination steps in vinyl polymerizations and copolymerization, preparation of block and graft copolymers by free radical initiated reactions and the mechanisms of free radical induced polymer degradation reactions.

9871:706 Ionic & Monomer Insertion Reactions (2 Credits)
Prerequisite: 3150:463/563 or permission of instructor. Covers the scope, kinetics and mechanisms of polymerizations initiation by anions, carbenium ions and onium ions as well as polymerizations induced by coordination catalysts. Living polymerizations, molecular weights, molecular weight distributions, stereo-chemistry, solvent effects, countercation effects, temperature effects, Ziegler-Natta catalysis, olefin metathesis, functionalization of polymers, graft and block copolymer synthesis.

9871:711 Special Topics: Polymer Science (1-3 Credits)
Prerequisite: permission. Topics of current interest in polymer science, encompassing chemistry, physics or technological aspects of macromolecular substances, including laboratory work where applicable.

9871:712 Special Topics: Polymer Science (2 Credits)
Prerequisite: permission. Topics of current interest in polymer science, encompassing chemistry, physics or engineering aspects of macromolecular science.

9871:720 Elastomers (2 Credits)
Pre/Corequisites: 9871:601 and 9871:631 or equivalent as determined by instructor. The course will provide a comprehensive coverage of the fundamental aspects of elastic soft materials, their chemical, physical and mechanical properties as related to their current technological applications.

9871:899 Doctoral Dissertation (1-16 Credits)
Open to properly qualified students accepted as candidates for Doctor of Philosophy in Polymer Science depending on the availability of staff and facilities.

Polymer Science and Polymer Engineering (9801)

9801:605 Polymer Physical Chemistry (4 Credits)
Fundamentals of polymer chain characteristics, common polymerization types, and overview of polymer physical chemical behavior.

9801:615 Polymer Characterization (4 Credits)
Prerequisite: 9801:605. Introduction to widely used polymer characterization techniques (3cr) with accompanying experiments (1cr).

9801:635 Rheology, Processing and Evaluation of Polymeric Materials (4 Credits)
Prerequisite: 9801:605. Introduction to several types of polymer processing and several tests of properties (3cr) with accompanying lab environments (1cr).

9801:645 Research, Problem Solving and Communication of Technical Information (3 Credits)
Prerequisite: 9801:605. Introduction to the research and development enterprise, problem solving, and the communication of technical information to various audiences.

9801:665 Emerging Markets & Technologies (3 Credits)
Prerequisites: 9801:605, 9801:615, and 9801:635. Overview of emerging markets and technologies involving polymers as well as analyses of these technologies with respect to life cycle, carbon footprint, and sustainability.