MTEN 205 Mechanical Behavior of Materials

Credits and contact hours
3-2-0 (3 lecture hr/wk-2 lab hr/wk-4 course credit)

Tuesday: 8:30 am – 11:20 am
Thursday: 8:30 am – 10:25 am

Instructor: Irina Molodetsky https://njit-edu.zoom.us/my/irina.molodetsky
email: Irina.Molodetsky@njit.edu

Textbook

1. Callister, W. & Rethwisch, D. *Materials Science and Engineering: An Integrated Approach*, John Wiley & Sons, USA, 6th edition
2. Meyer, M. & Chawla, K. Mechanical Behavior of Materials, Cambridge University Press, 2009, eBook
3. Additional instructional materials will be provided on Canvas

Specific course information

a. Description:

The course offers experiential learning the essential characteristics of the mechanical behavior of solid materials. Experimentally measured normal and shear stress-strain behavior in metals, hardness in metals and ceramics are discussed using chemical bonding, crystal geometry, and different types of lattice defects. Complexity of mechanical behavior of polymers and composites is demonstrated on polymers with different controlled macrostructures. Students learn about thermal stresses on real-life examples of ceramic-to-metal braze assemblies and thin film epitaxy. Students will get acquainted with ASTM, perform macrostructural analysis of material and characterize a type of mechanical failures. The course will include written and oral presentations of individual and team projects.

Prerequisites: MATH 211 or MATH 213, and MTEN 201

Specific goals for the course

The student will be able to:

- Prepare metallographic samples for evaluation of the macrostructure.
- Conduct and interpret tensile and shear stress tests on metal and plastic materials and plot engineering and true stress-strain.
- Relate mechanical behavior during tensile and shear tests to micro-and macrostructure of the material.
- Formulate silicone matrix composite material and perform hardness measurement.
- Predict a difference in mechanical strength of alumina based on experimentally measured grain size, amount of glass phase and voids.
- Calculate bilateral stress in the epitaxial grown film.
- Justify a choice of materials for braze assembly.
- Characterize brazed ceramic-metal interface to meet ASTM standard.

Topics

1. Introduction. Different mechanical behavior of materials – examples from nature. Importance of mechanical testing and standards. Testing of fundamental mechanical properties of materials and specific tests driven by application.
2. Definition of terms. Stress and Strain. Hooke's Law: normal and shear moduli. Microscopic basis of elasticity. Poisson ratio. Bulk modulus (2-3).
3. Tensile test: elastic and plastic behavior of materials. Engineering and true stress-strain. Sound propagation in elastic materials (3-4).
4. Macroscopic and microscopic plastic deformation. Defects: definition of terms. Effects of grain size and grain boundaries on the mechanical properties of materials. Dislocations. Generation and movement of dislocations. Dislocation mobility in alloys, solid solutions and intermetallics. Preferential etching (5-7).
5. Thermal stresses (normal, shear, bilateral) and design for manufacturing (8-9).
6. Mechanical behavior of ceramics and glasses. Fractures. Bioinspired materials with superior mechanical performance. Ceramics with advanced mechanical performance – micro-and macrostructure-properties relationship (9-10).
7. Mechanical properties of plastic materials. Glassy, rubbery and viscous regimes. Three-points test of plastic materials. Negative thermal expansion of rubbers. Viscoelasticity (11-12).

Course Structure

1. Weekly lecture component – active participation in discussions (5%)
2. Homework assignments (5 %)
3. Five laboratory experiments on mechanical behavior material (70 %)
   - Bi-Weekly individual presentation of laboratory experiments
   - Laboratory reports
4. "Let's find out" final project and presentation. Topics defined during class discussions (20 points).

Communication

1. This course will use the NJIT Canvas site accessed by http://canvas.njit.edu for all communications regarding changes in the schedule, status of the experiments, score rubrics, files and documents.
2. All online communications are done using Zoom
3. Additional individual or team discussions will be scheduled on Canvas and require you to sign up to a specific slot.
4. If circumstances require online communication with the entire class, it will be done through **Zoom** hosted by the instructor

Grading

Above 90 A
Above 85 B+

Above 80 B
Above 75 C+
Above 70 C
Above 60 D
Below 60 F

Professional Behavior

- You are expected to participate in the class discussions
- Support inclusive learning environment
- Provide feedback to instructor using "muddy" point submission on Canvas site (extra point assigned to a good question related to topics discussed in class)

- Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at:

http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. ***Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university.*** If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at *dos@njit.edu*"

www.njit.edu/academics/pdf/academic-integrity-code.pdf

Accommodations due to a disability

If you need accommodations due to a disability please contact Marsha Williams-Nicholasto, Associate Director of Disability Support Services, Kupfrian 201 to discuss your specific needs. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodation will be required.

Use of artificial intelligence (AI)

This course expects students to work without artificial intelligence (AI) assistance in order to better develop their skills in this content area. As such, AI usage is not permitted throughout this course under any circumstance