

MSE-669

Thin film and small scale mechanics

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Cursus	Sem.	Type
Materials Science and Engineering		Opt.

Language of teaching	English
Credits	2
Session	
Exam	Written
Workload	60h
Hours	32
Courses	28
Exercises	4
Number of positions	24

Frequency

Every 2 years

Remark

November 2022. Please register directly on the course website, not on IS-Academia.

<https://www.epfl.ch/research/domains/ccmx/courses-and-events/mse-669-thin-film-and-small-scale-mechanics/>**Summary**

The course focuses on mechanics of solid thin films and small scale structures and on state-of-the-art experimental techniques employed for evaluation and extraction of thin films and small scale structures mechanical properties. Lectures are example intensive, with in depth theoretical analysis.

Content

Introduction, Microstructure of Materials, Materials Mechanics, Contact Mechanics, Mechanics of Thin Films, Mechanics of small scale structures, Size effects, Micromechanical sample preparation, Small scale mechanical testing techniques and instrumentation, Methods to assess adhesion, residual stress, and tribological properties.

The course focuses on mechanics of solid thin films and small scale structures. It commences with a review of concepts in materials microstructure (bond types, crystallography, amorphous materials) and material mechanics (stress and strain, linear elasticity, plasticity, linear fracture mechanics, time-dependent behavior, fatigue). This is followed by an overview of the field of contact mechanics. A brief introduction is given concerning deposition and characterization methods. Stress evolution in thin films is covered in detail as is the effect stress may have on the solid thin film failure (e.g. fracture mechanics of the interfaces and thin films, delamination and buckling of thin films, contract fracture mechanics). Testing methods to assess film adhesion, residual stress levels and tribological properties are re-viewed. Further, lectures will cover size effects encountered when testing intrinsic properties of microscale samples and thin films. Lectures will be example intensive, with a due attention given to understanding mechanics of these important examples. A whole section of the course will be focusing on state-of-the-art experimental techniques available today for evaluation and extraction of thin films and small scale structure mechanical properties (nanoindentation, micropillar compression, microtension, experiments at cryogenic or elevated temperature, high strain rate testing). The block-type half day course lectures conclude with instrument demonstrations and related laboratory training and exercises. The last course day will conclude with an extended 4 hours laboratory exercise.

Note

Textbook: L.B. Freund and S. Suresh, Thin Film Materials, Cambridge Univ. Press 2004 (textbook is not necessary for course participation, handouts and lecture notes will provide sufficient information but the textbook is a valuable reference for anyone working in the field). The course will be held throughout 22.11.22 through 25.11.22 at EMPA in Thun so that participants can witness and take part in actual experimental evaluations and testing of thin films.

Keywords

Small scale mechanics, thin film mechanics

Learning Prerequisites

Required courses

Basic knowledge of solid mechanics and materials (e.g. elasticity, strength of materials, continuum mechanics, microstructure and chemistry of materials)

Assessment methods

Written

Resources

Bibliography

<https://www.empa.ch/web/s206/johann-michler>

<https://www.empa.ch/web/s206/jakob-schwiedrzik>