

# Introduction

Nondestructive Testing of Materials  
(BMEGEMTAGE2)  
08. 09. 2022.

# Department of Materials Science and Engineering



**MT building**

# Department of Materials Science and Engineering

Head: Prof. Peter J. Szabó  
Homepage: [www.att.bme.hu](http://www.att.bme.hu)

- Student administration:
  - MT building, first floor (dr. Tibor Berecz)
  - MT building, ground floor (dr. Dorina Kovács)

# Education in the Department of Materials Science and Engineering

## **BSc**

**Basic subjects:** Materials Science and Testing  
Metals and Ceramics Technology

**Specialization:**

Materials Forming  
Welding  
Heat Treatments  
Non-destructive Testing  
Quality Assurance

# MSc

**Basic subject:** Materials Science

**Specialization:**

Materials Forming

Welding

Metallurgy, powder metallurgy

FEM Engineering (MSC MARC)

Ceramics, Composites

Biomedical Materials

Corrosion

Fatigue, Fracture

Microstructural Investigation

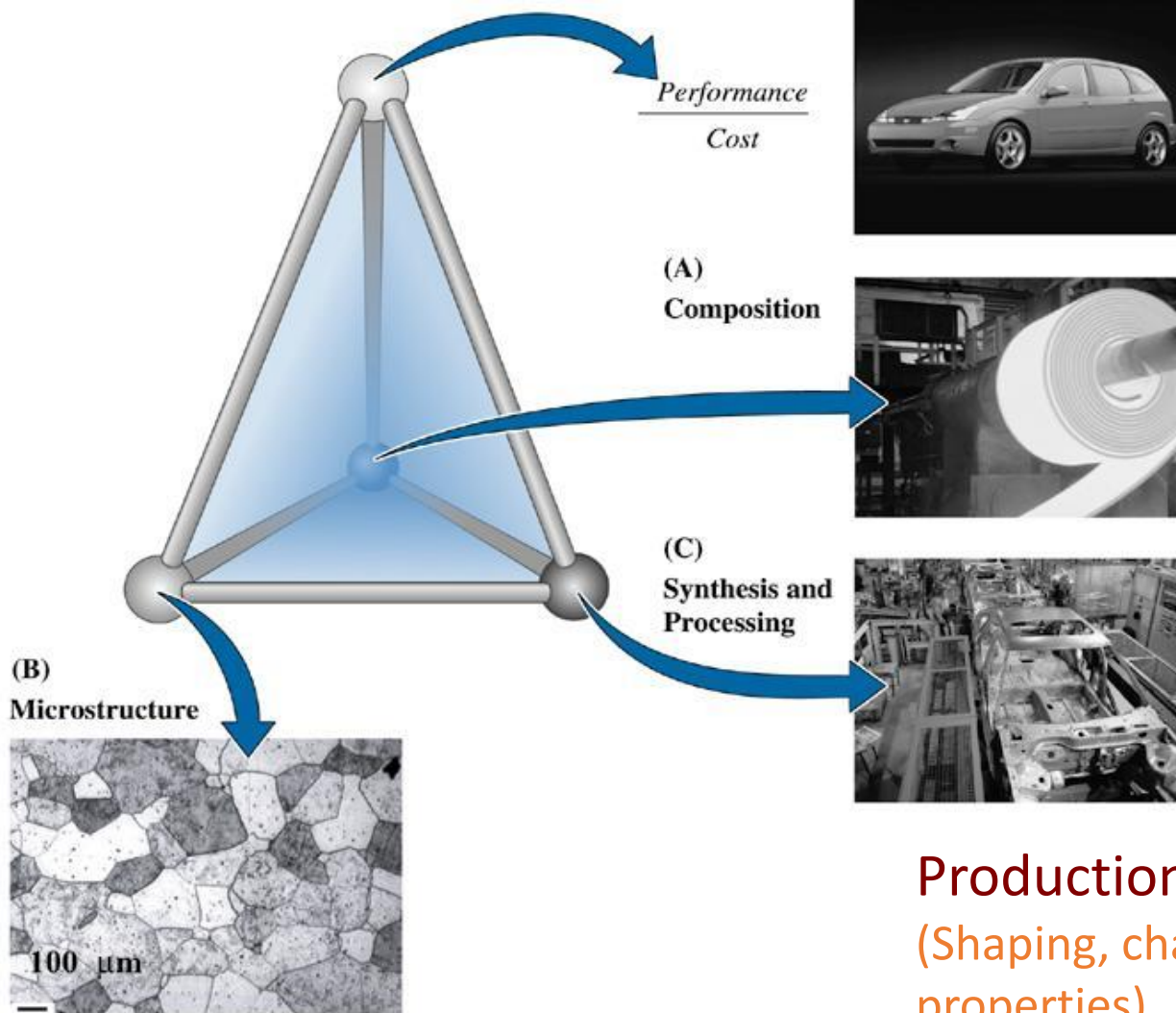


- **Materials Science**

The connection between the materials properties and the structure of the materials, „WHY”.

- **Materials Technology**

Using the connections above, we can plan and construct materials for different purposes, „HOW”.



Application

Properties

Production  
(Shaping, changing of properties)

Microstructure (How the material looks like?)

- **Mechanical** (effect of loading and strain)
- **Electronic** (effect of electrical field)
- **Thermal** (effect of heat)
- **Magnetic** (effect of magnetic field)
- **Optical** (effect of electromagnetic field)
- **Damage** (chemical reactivity)



- Due to loading the materials by a certain energy, the structure (and therefore the properties) of the materials may change.
- The structure of the material is changed intentionally → materials *technology*.
- The structure of the material is changed during operation → *degradation* due to operational *loading*.
- Loading can be classified according to the type of the energy of the loading.

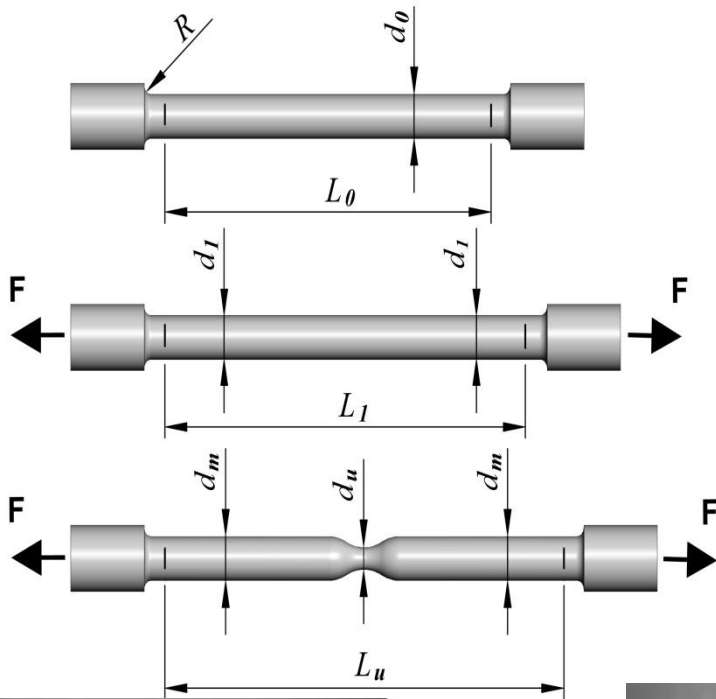
- Mechanical loading
  - Static
  - Dynamic
  - Periodic
  - Deformation, wear, fracture, fatigue, creep, etc.
- Thermal loading
  - Thermally activated processes
- Chemical loading
  - E.g. corrosion
- Irradiation
  - Fast neutron irradiation

- Electric effects
  - Contacts, arcs
  - Heating due to electric current
  - Piezoelectric effect
- Biological effects
  - Application in special environments
  - Microbiological attacks
- Combined effects

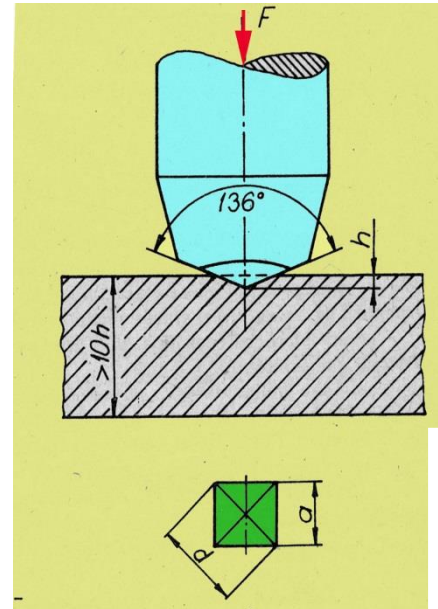
During materials testing an excitation is given to the material, and the response of the material to it is detected.

- Mechanical
- Electrical
- Magnetic
- Optical
- Radiation
- Thermal
- Combined

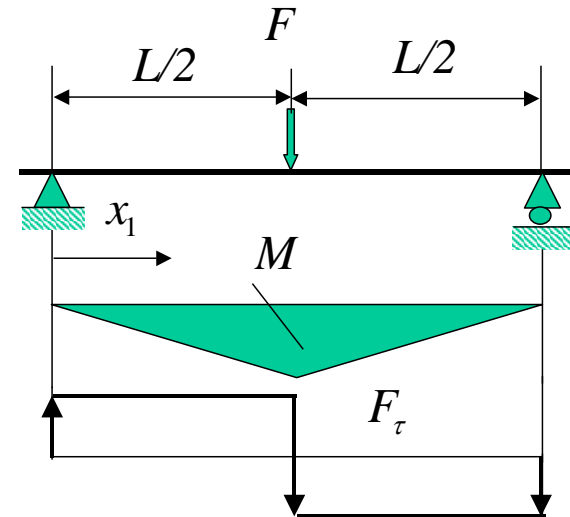
## Tensile test



## Hardness

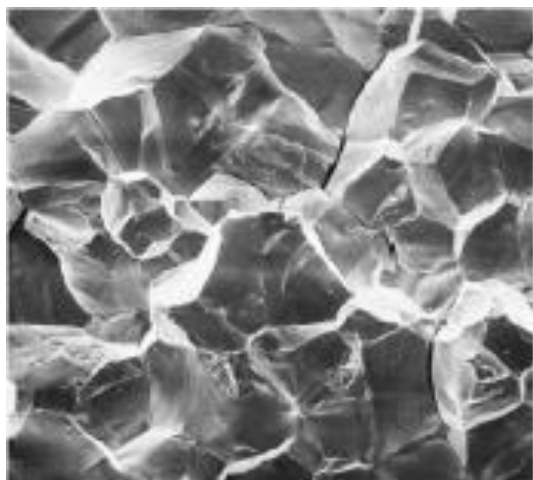


## Bending

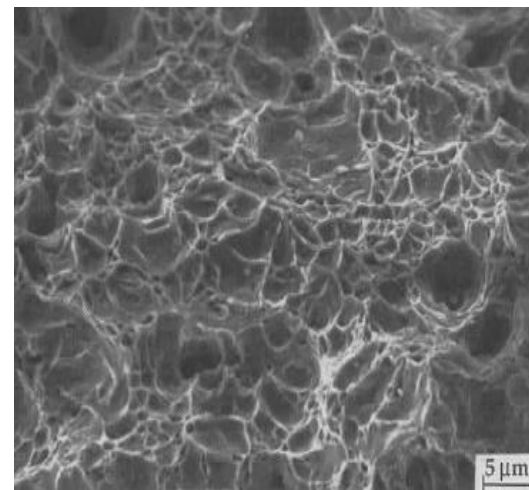




- Mechanical
  - Determination of the mechanical properties of the materials: yield stress, strength, ultimate stress, elongation, contraction
- Chemical
  - Determination of the chemical composition
- Physical
  - Determination of physical properties (conductivity, magnetic properties, thermal expansion, etc.)
- Crystallographical
  - Determination of the crystalline structure
- Imaging methods
  - Forming an image of the material (optical microscope, electron microscope, atomic force microscope, etc.)
- Metallographic methods
  - Determination of microstructure, grain size, inclusions, etc.

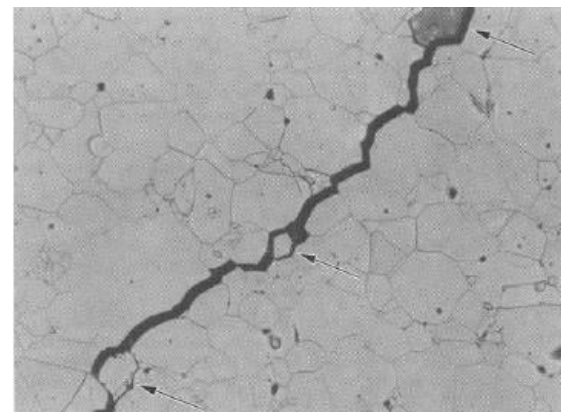
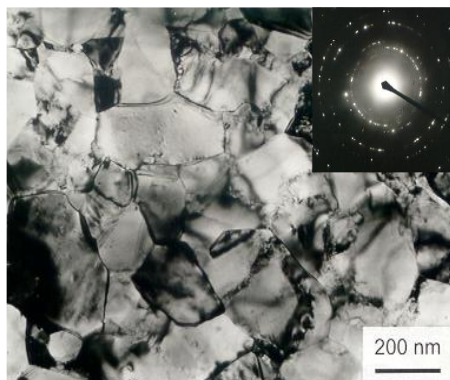


Brittle behaviour



Ductile behaviour

Transmission



Optical microscope

- Static tests
  - Tensile, compressive, bending, (static) hardness
- Dynamic tests
  - Charpy test
  - Brittle, ductile behaviour
  - Dynamic hardness tests
- Technological tests
  - Reactions against different technological steps
- Nondestructive tests

- Definition I. (strict)
  - After the test the investigated part can be used in its original form for its original purpose
- Definition II. (more flexible)
  - The specimen is not deteriorated during the test (however the original part can not always be used for its original purpose, e.g. because we had to cut a small piece for the test)

- Visual inspection
- Liquid penetration
- Test with magnetic powder
- Eddy-current methods
- Ultrasonic methods
- Radiography
- Acoustic emission
- Porosity test
- ...

- Optical microscopy
- Confocal laser microscopy
- Acoustic microscopy
- X-ray diffraction
- X-ray microscopy
- Electron microscopy (SEM, TEM)
- Scanning tunneling microscopy
- Atomic force microscopy
- ...