Polymeric Materials Testing

Molecular Properties
- chemical structure
- intermolecular interactions
- additives
- filler / reinforcing fibers

Application Properties
- mechanical properties
- thermal properties
- electric properties
- acoustic properties
- etc.

Materials Testing Method
- temperature
- time / rate / frequency
- load
- environment

Polymeric Materials Testing

Structure
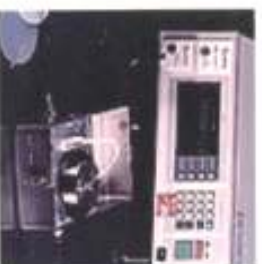
Optical

Electrical

Thermal

Mechanical

Rheological

Influence of Temperature and Time

Stress
σ in N/mm²

100
50
0

100
200

ε in %
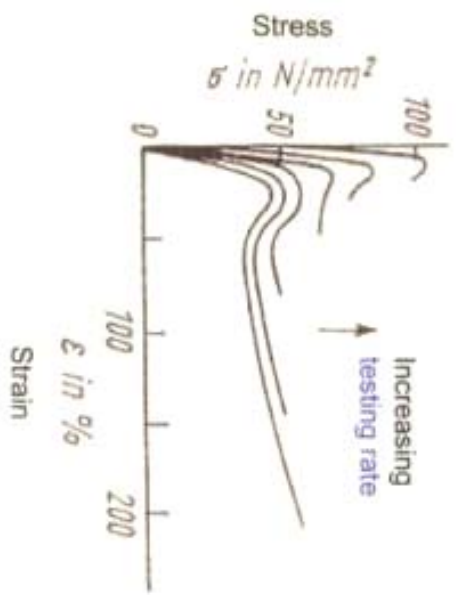Strain

Increasing
testing rate

Stress
σ in N/mm²

100
50
0

100
200

ε in %
Strain

Increasing
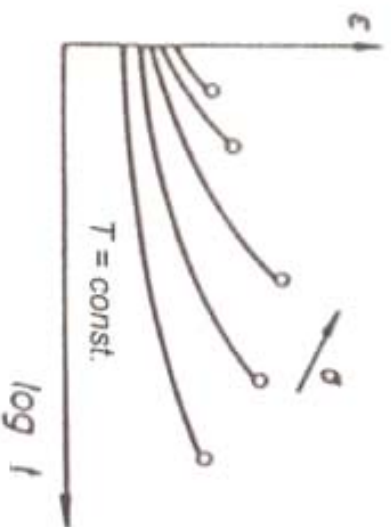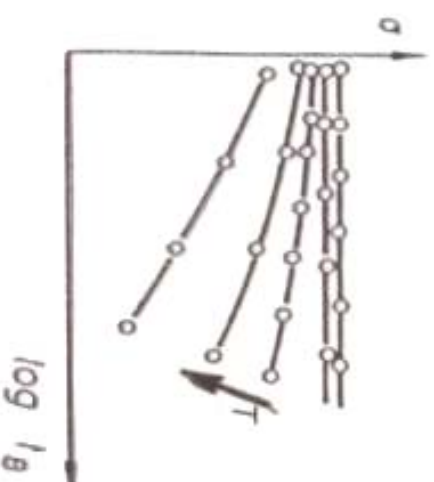temperature
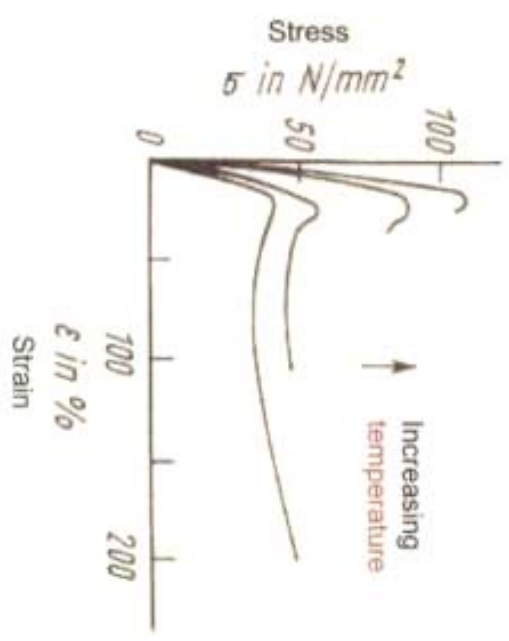
Stress-strain behaviour of a thermoplastics in dependence on testing rate and testing temperature

Influence of Temperature and Time
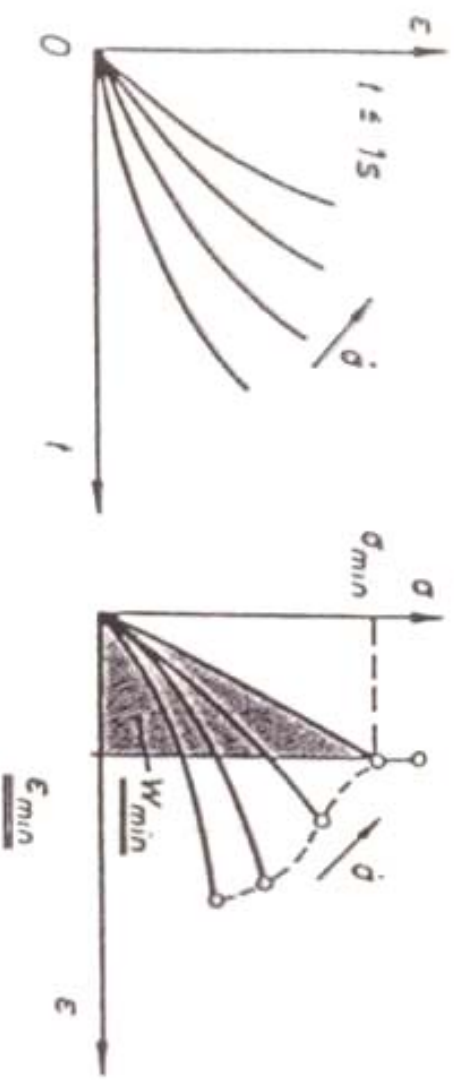
Temperature

Deformation behavior in dependence on time (creep) and load

Stress-time behavior at various temperatures

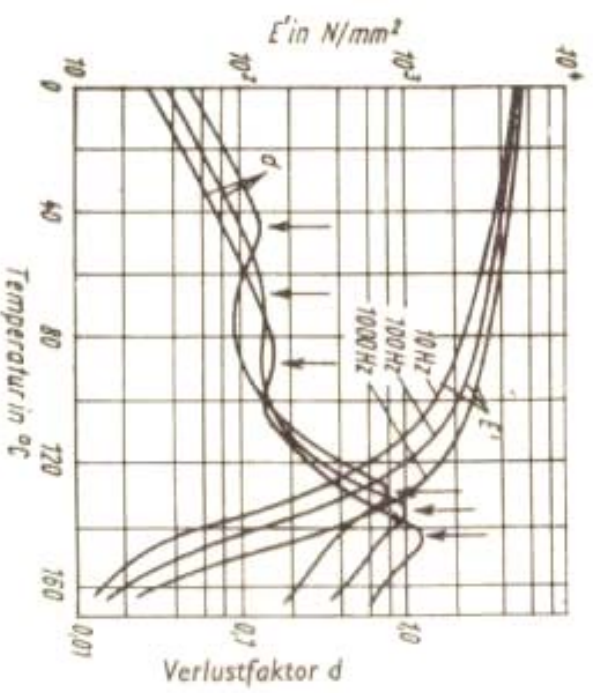# Influence of Temperature and Time

Time

Deformation and failure at different stress rate at impact load
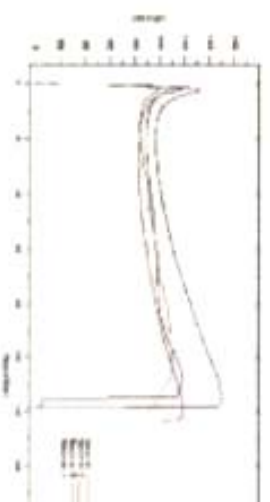
Influence of Temperature and Time

Time-dependent deformation behavior

Dynamic modulus E' and loss factor d in dependence on temperature measured at various frequencies
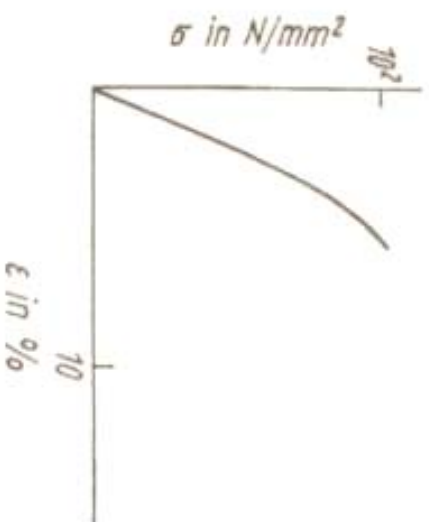
Testing Methods

Stress-strain behavior

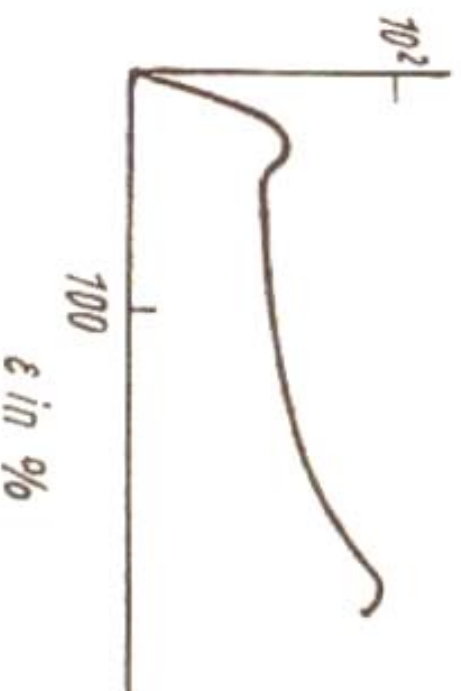### Tensile test

Universalprüfmaschine Zwick UPM 1465

Testing Methods

Stress-strain behavior

Tensile test

σ in N/mm²

10^2

ε in %

10

Stress-strain behavior of thermosets or thermoplastics in the brittle state

10^2

100

ε in %
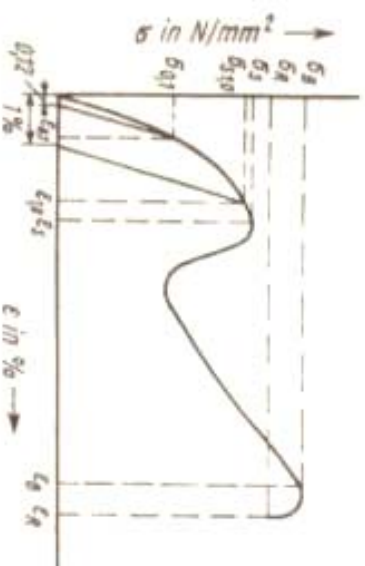
Stress-strain behavior of thermoplastics in the tough (ductile) state

Testing Methods

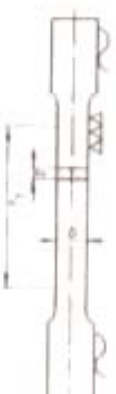## Stress-strain behavior
Tensile test

Tensile test specimen

Parameters

Tensile strength = $\dfrac{\text{Tensile force}}{\text{Initial area}}$

$$\sigma = F / A_0$$
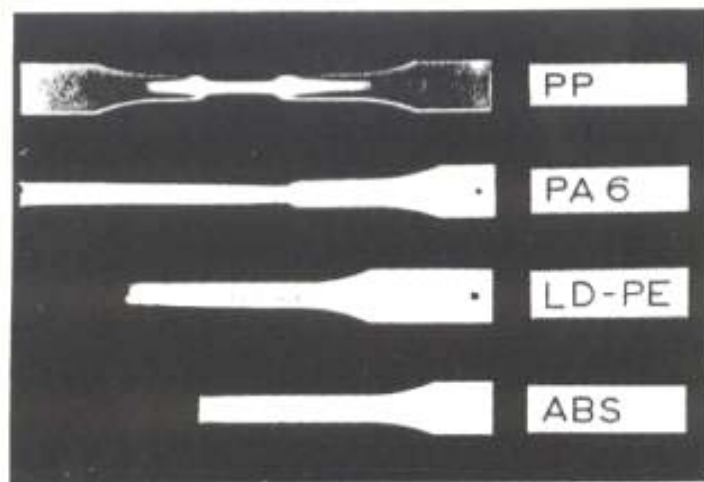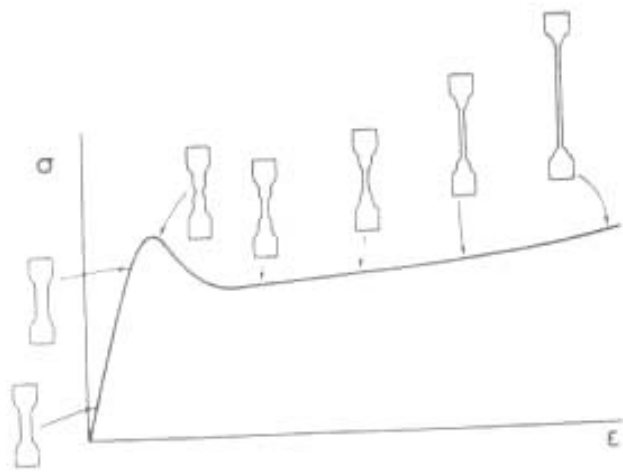
Tensile strain = $\dfrac{\text{Extension}}{\text{Initial length}}$
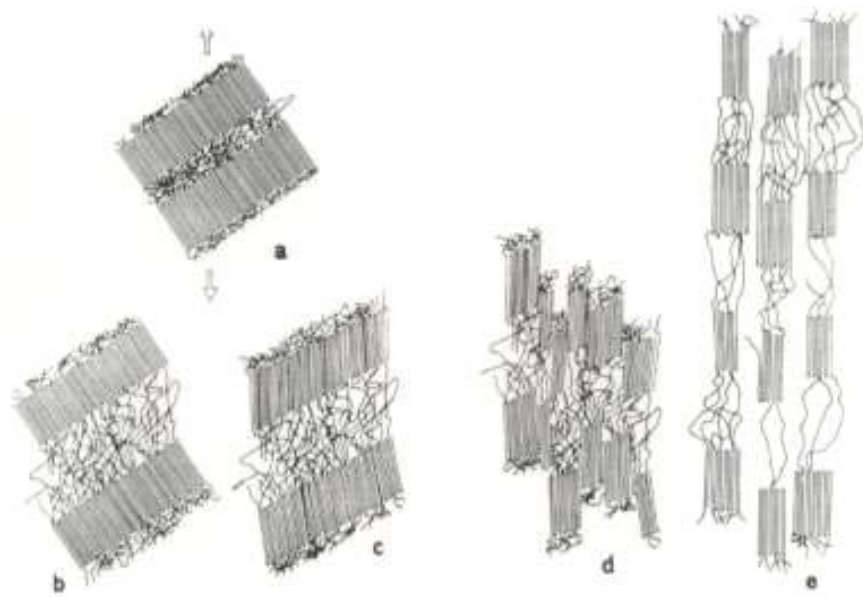
$$\varepsilon = (L - L_0) / L_0$$

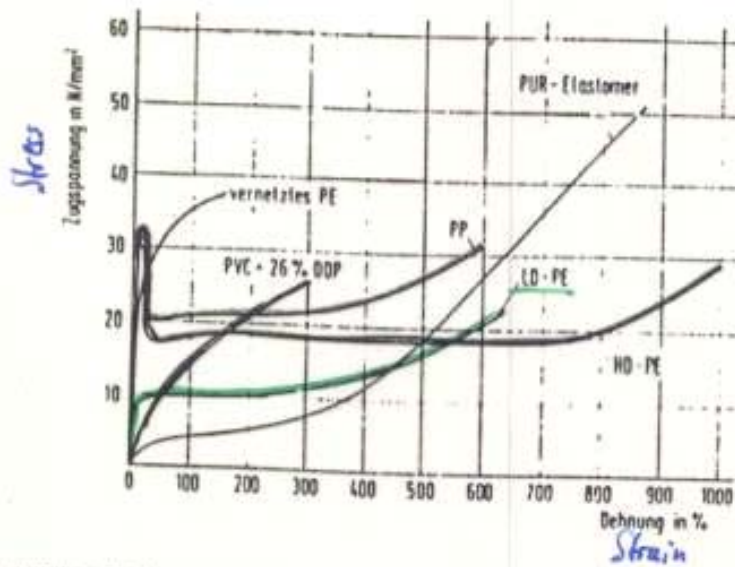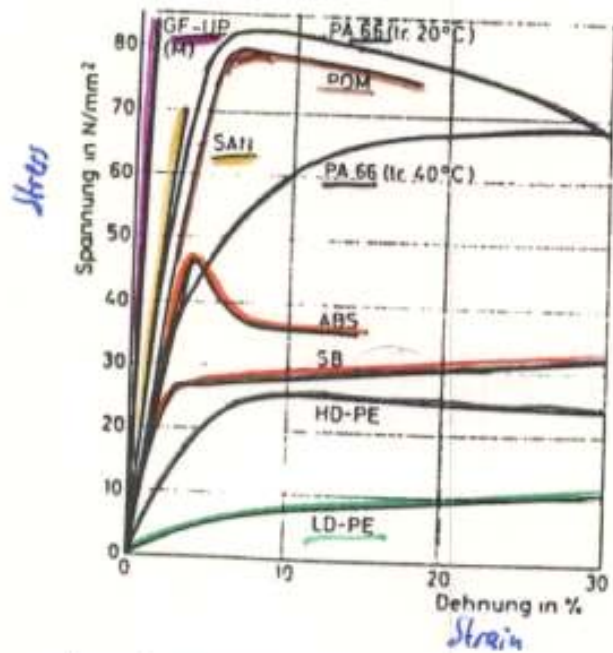Modulus of elasticity = slope of the stress-strain curve

$$E = \Delta\sigma / \Delta\varepsilon$$

σ

ε

PP

PA 6

LD-PE

ABS

a

b   c   d   e

Top graph axis labels:
- Y-axis: Spannung in N/mm² — *Stress*
- X-axis: Dehnung in % — *Strain*

Curve labels (top graph): GF-UP (H), PA 66 (tr. 20°C), POM, SAN, PA 66 (tr. 40°C), ABS, SB, HD-PE, LD-PE

Bottom graph axis labels:
- Y-axis: Zugspannung in N/mm² — *Stress*
- X-axis: Dehnung in % — *Strain*

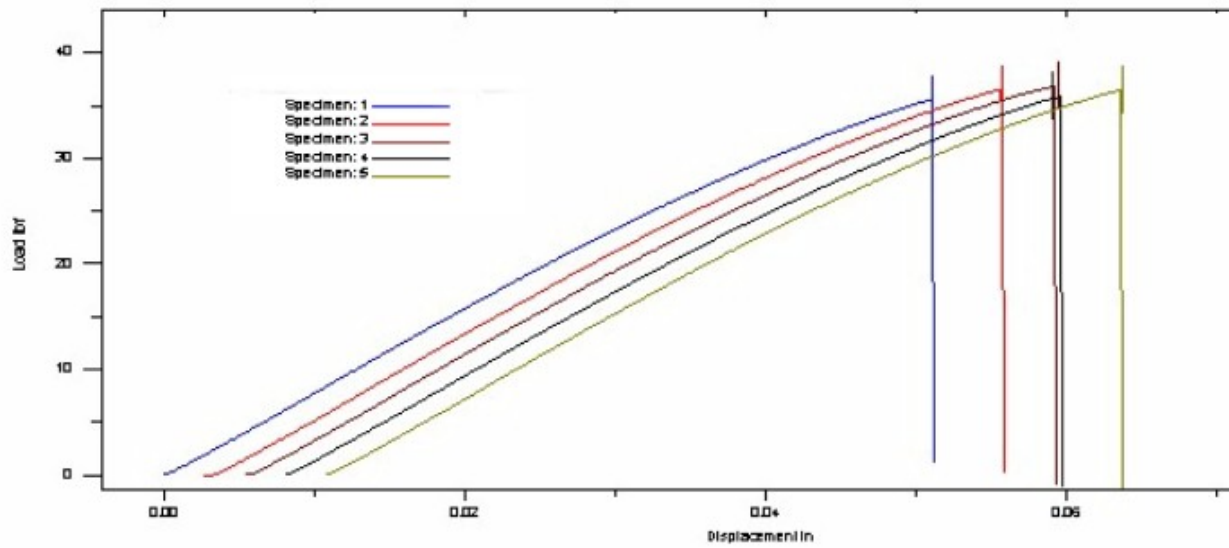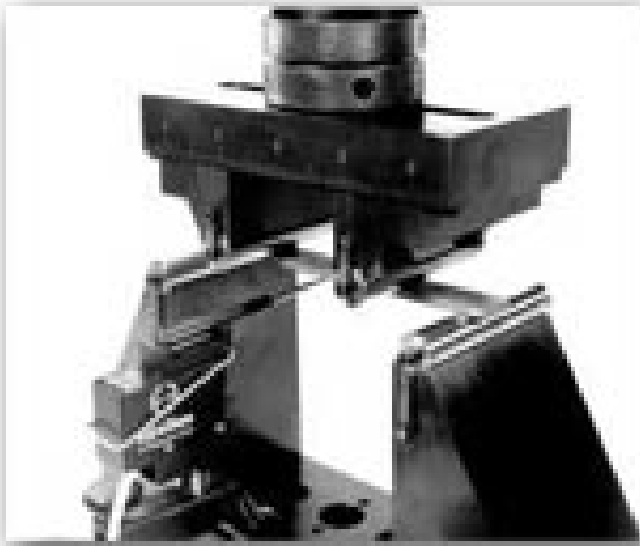Curve labels (bottom graph): PUR-Elastomer, vernetztes PE, PVC + 26 % DOP, PP, LD-PE, HD-PE

Zugspannungs-Dehnungs-Kurven für verschiedene Polymer-Werkstoffe

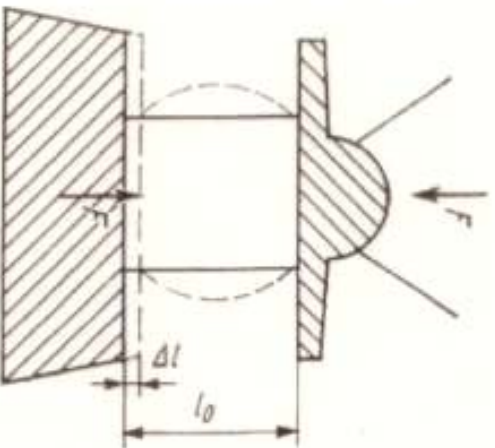Stress-strain behaviour of various Polymer Materials
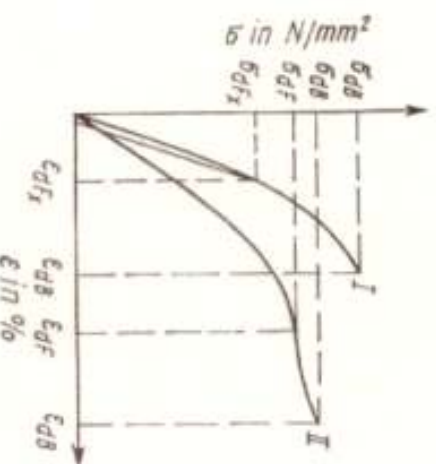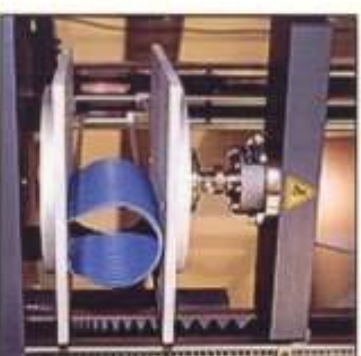
Testing Methods
Bending test

Testing Methods

Pressure test

Testing principle

Compression diagramm

Compression test
at a construction part

Testing Methods

Impact test
IZOD

Testing Methods
Impact test