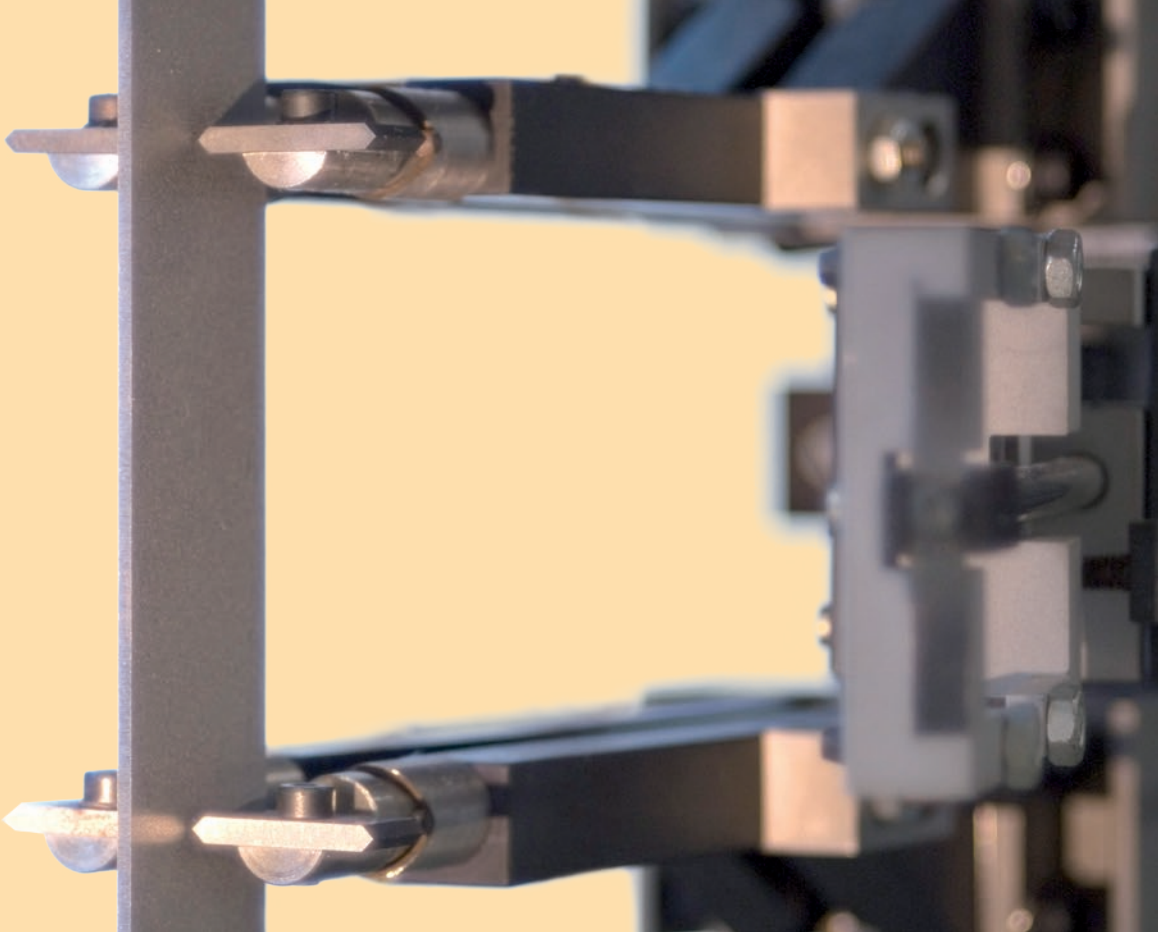

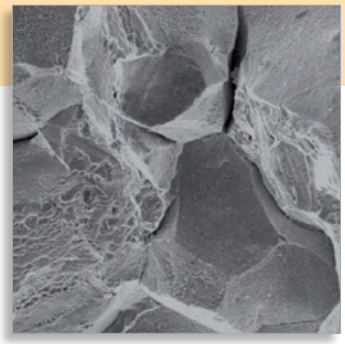

Mechanical Testing

- all solid materials
- wide range of mechanical properties
- standard and custom-made test set-ups
- application-focused tests
- mechanical and materials consultancy

Mechanical testing incorporates the measurement of the material's mechanical response to an applied force or displacement. Our large portfolio of testing facilities enables determination of many mechanical properties (see table 1). Depending on the information required, dedicated tests can be performed. Numerous projects in- and outside Philips are supplied with mechanical data that are used as input for modeling activities, materials selection, problem solving, and virtual prototyping.

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Technique	Obtained information
Uni-axial testing	• Axial force • Changes in dimensions • Displacements • Engineering and true stress-strain curves
Time-resolved Uni-axial testing	• Strain rates/velocities • Stress rates/velocities • Creep • Stress relaxation • Recovery after unloading
Hardness measurements	• Vickers' hardness (HV) • Rockwell-Cone hardness (HRC) • Rockwell-Ball hardness (HRB)
Combined techniques	• Influences of force or stress on electrical properties like resistance or capacitance • Friction coefficients in tribological systems
Other tests	• 2-, 3-, 4- point bending • Peel • Delamination • Shear • Ring-on-ring/ball-on-ring

Table 1: our portfolio of mechanical testing techniques.

Applications

- Verification of certain mechanical properties of an ordered batch of material
- Mechanical characterization of lesser known materials (like super alloys and membranes, see also figure 1)
- Electrical resistance measurements of flexible displays or stretchable electronics
- Compliance measurements of springs
- Determination of the degree of hysteresis damping of polymeric and elastomeric foils
- Determination of the fracture toughness of laminated polymeric foils for medical devices
- Delamination studies of ICs and their compounds
- Strength measurements of welds
- Fracture path studies in adhesively bonded materials
- Determination of the ratio of the adhesive fracture surface to cohesive fracture surface, of an adhesive bond in a tensile test (after fracture)
- Edge quality determination of diced Si-wafers by 4-point bending
- Calibration (or verification) of load cells
- Generally, measurements of forces, dimensions, displacements, if necessary as a function of time

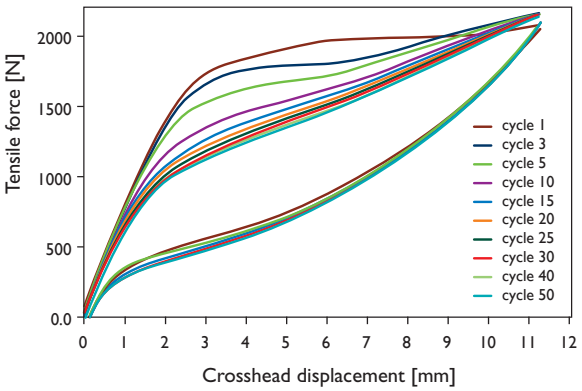

Fig. 1: Elastic deformation of Nitinol during a number of strain cycles. It is clearly visible that the super elastic properties change upon the number of cycles: the upper curves of the hysteresis loops do not overlap each other.

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Material Analysis lab
offers a full range of analytical methods and expertise to support both research and manufacturing, serving customers by taking an integral, solution-oriented approach.

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Characteristics

Information
- Mechanical properties

Sample type
- Virtually all solid materials and combinations thereof (metals, polymers, elastomers, ceramics, composites, bonds, welds), within temperature limits (-40°C to +450°C)
- Structures and assemblies within temperature, dimension, and mass limits

Sample quantity
- Dimensions in the order of cm or dm
- Minimum layer thickness of 5µm in cross-section for Vickers micro-hardness measurements

Detection limits
- Force measurements: 0.001 N – 1 N
- Calibrated force range: 0.02 N – 100 kN
- Minimal (longitudinal and transversal) displacement: 1µm (also contactless)
- Time-resolved measurements: 10 Hz
- Vickers (micro-)hardness: 0.05 gf to 30 kgf

Accuracy & Precision
- Dependent on technique and apparatus used

Test standards
- The tests can be performed according to quality standards like ASTM, ISO, EN, DIN, NEN, BS, JIS, Philips (UN) and AFNOR
- Custom-made tests

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