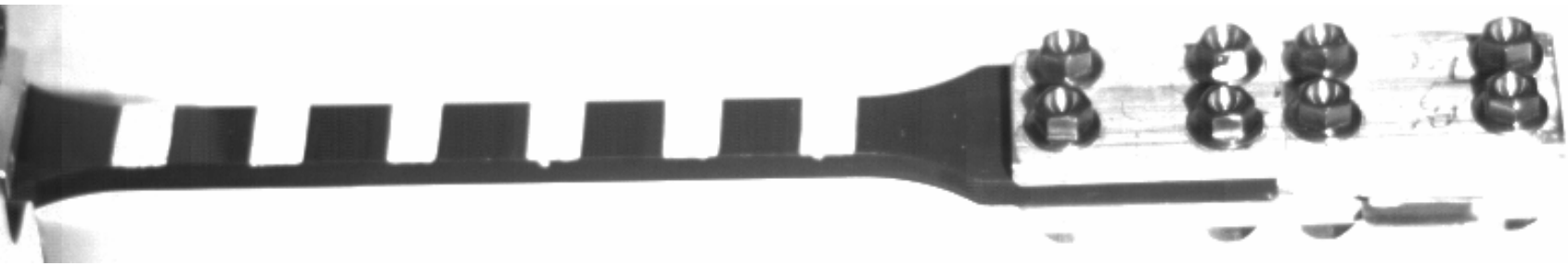
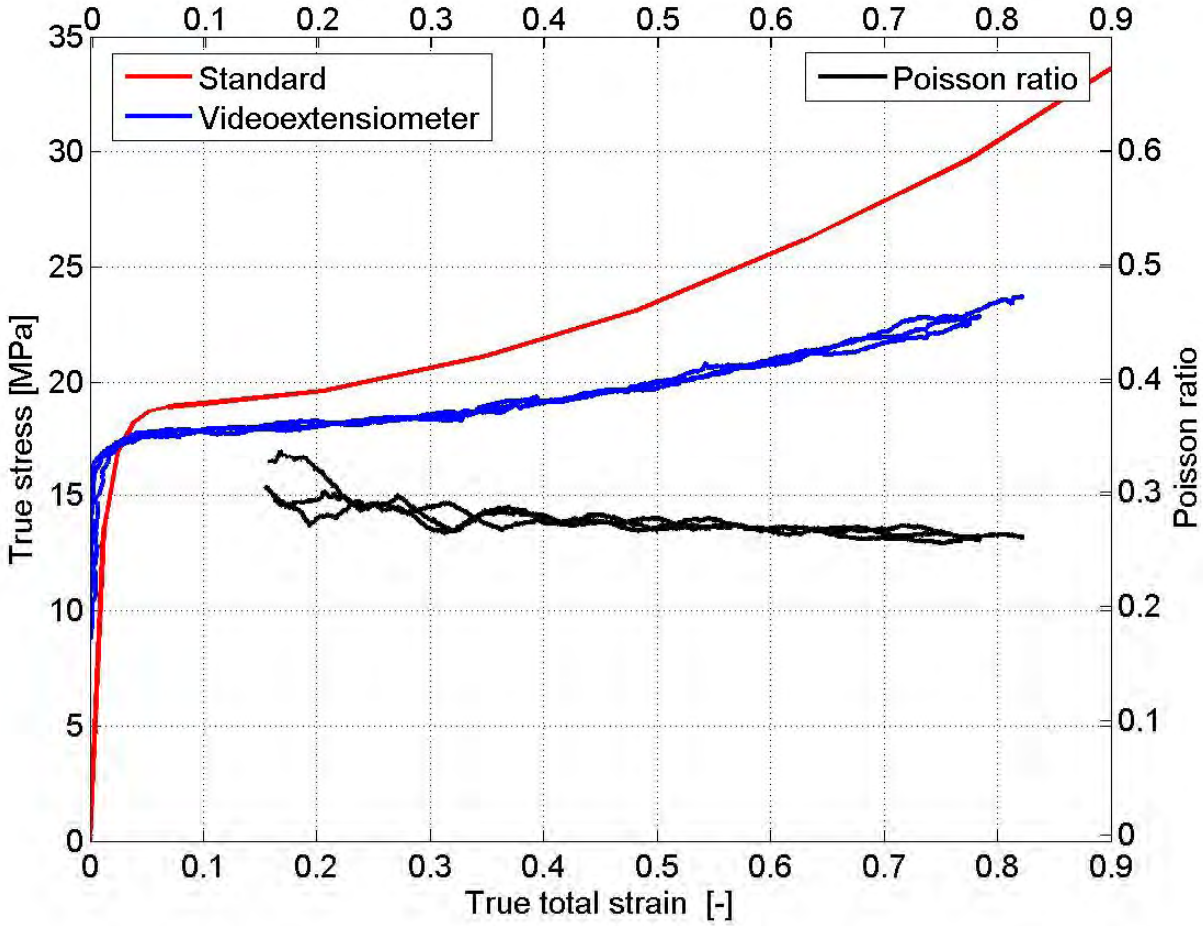
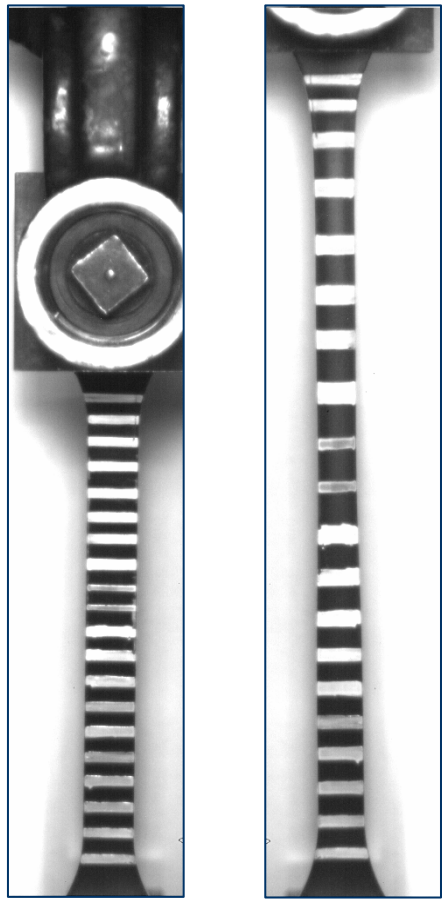
High-speed tensile testing

- Injection-moulded test specimen, polypropylene (bumper grade)
- Crosshead accelerated to speeds up to 10 m/s before gripping test specimen

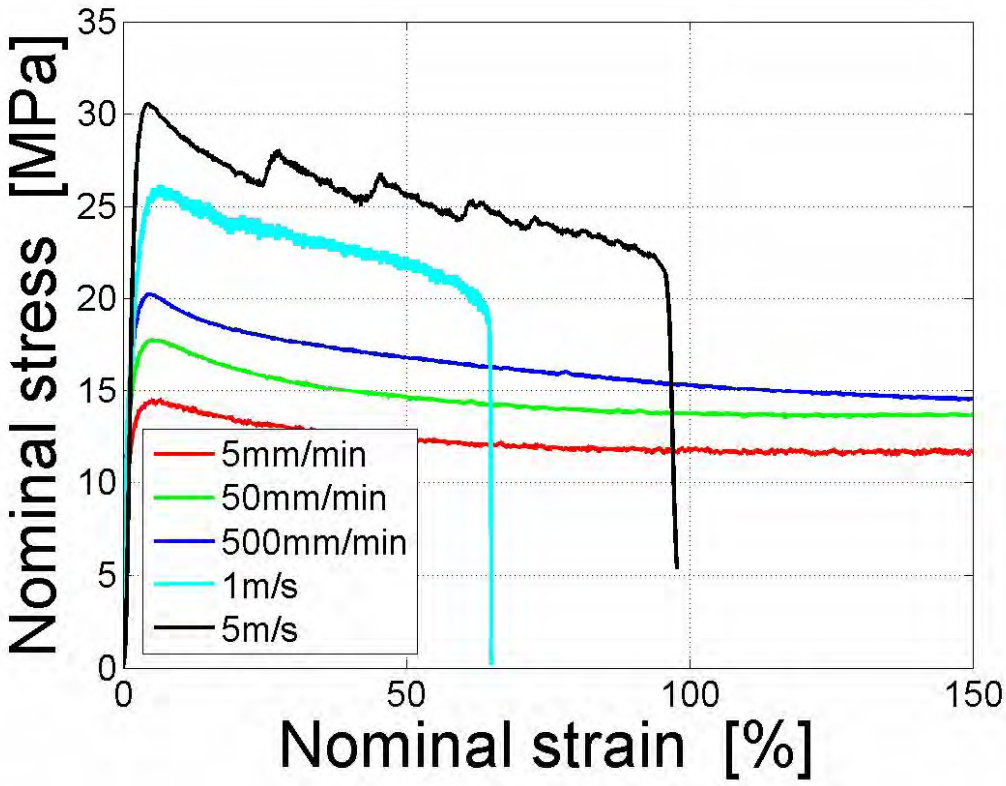


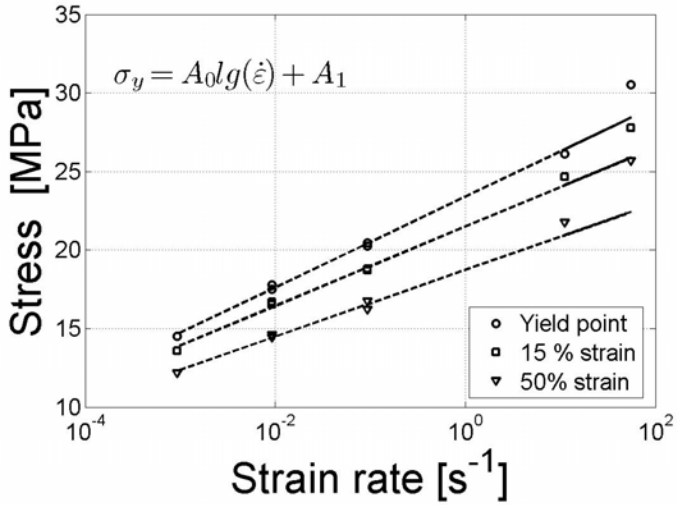
True stress-strain

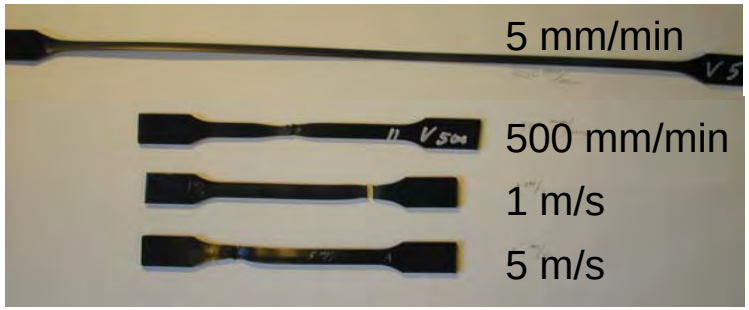




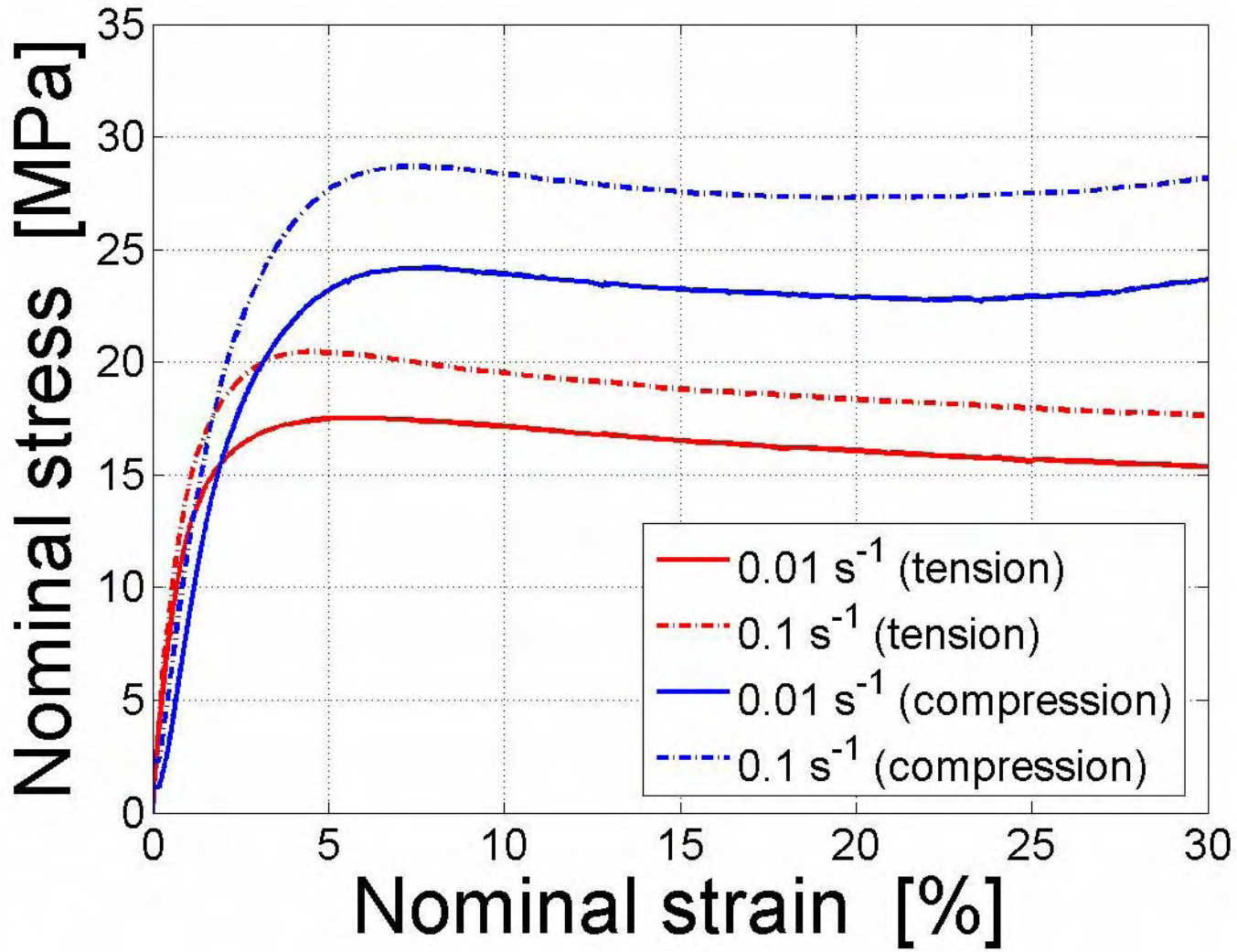
High-speed tensile testing







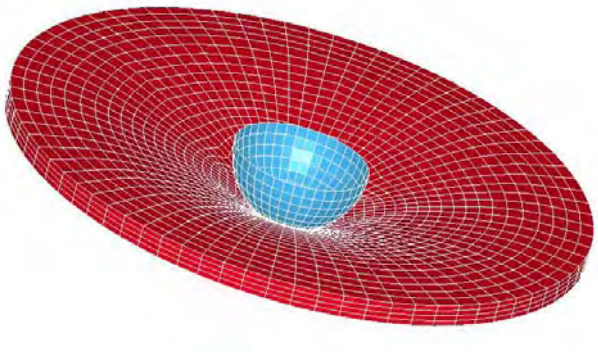
Different responses in tension and compression, modified Mises criterion

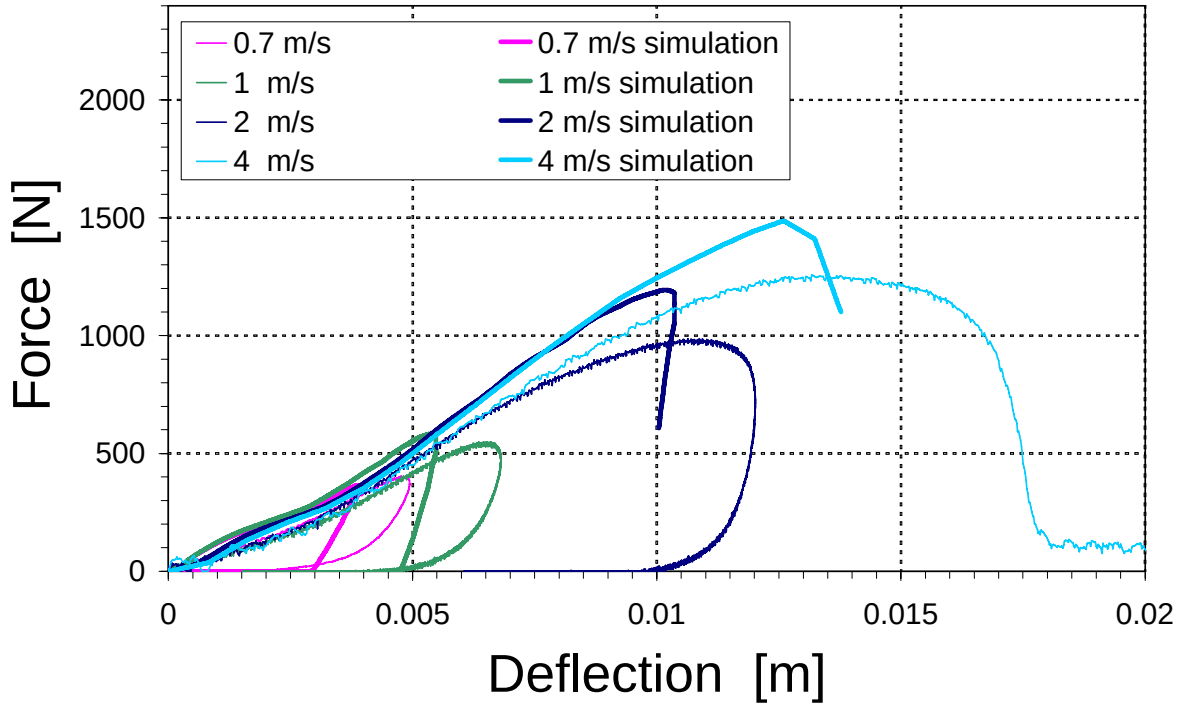


Material models for simulating impact response

Validation of models:

Comparing results from impact testing with simulations





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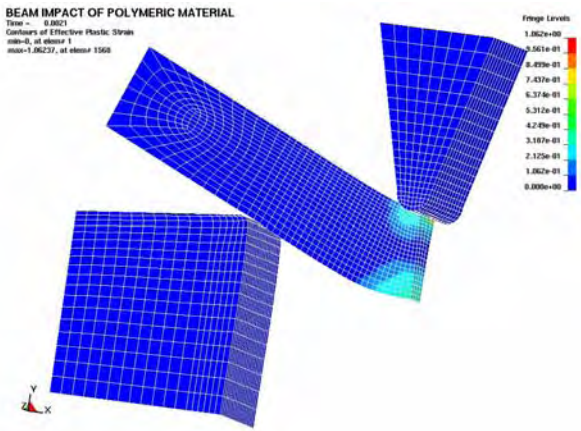
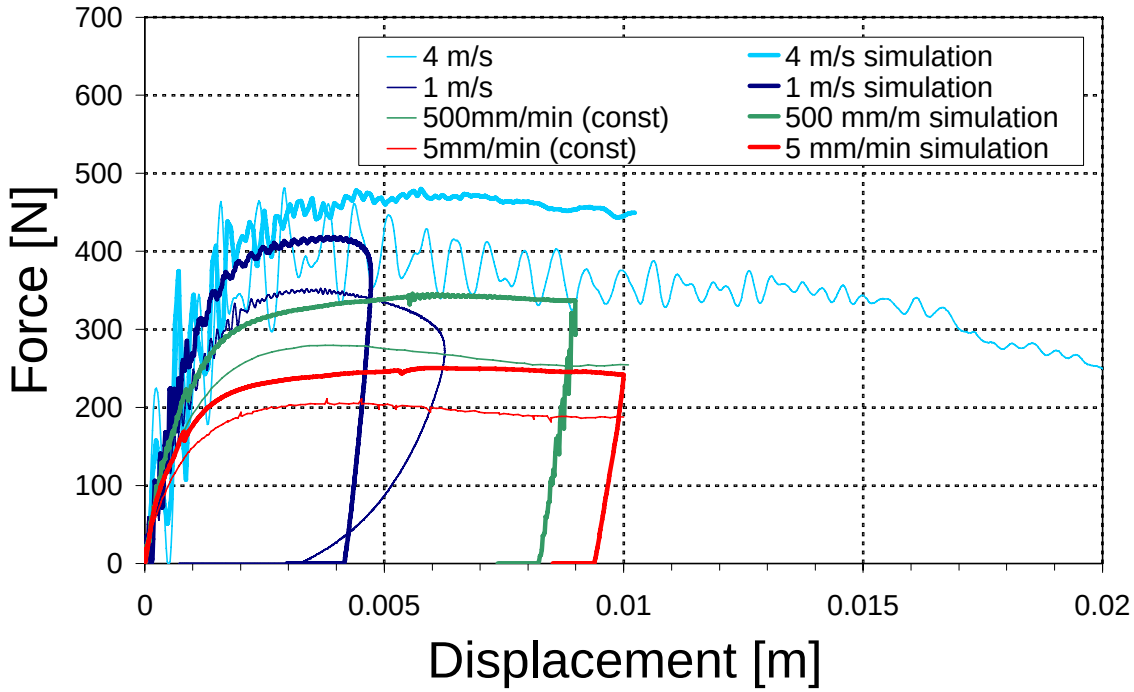
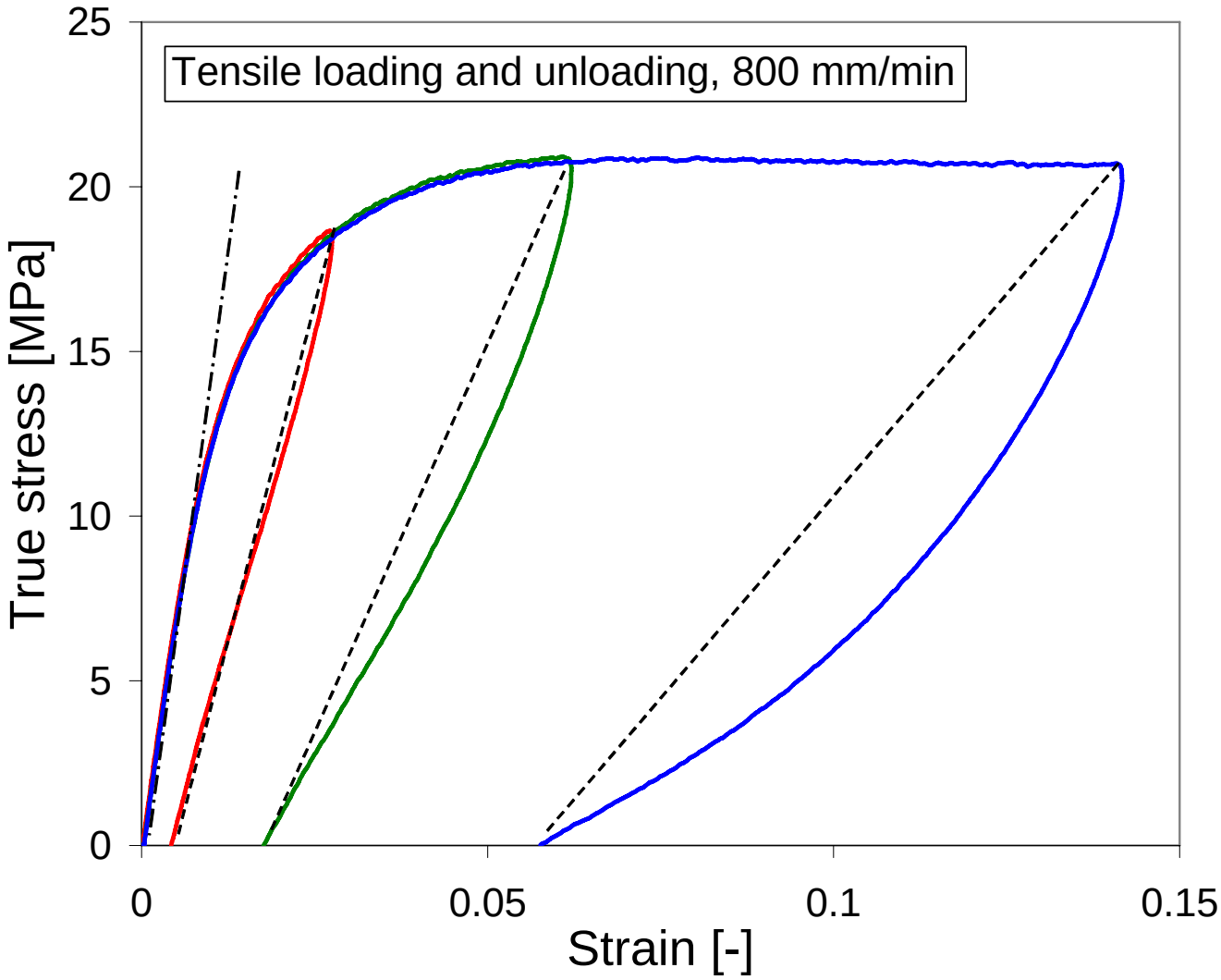




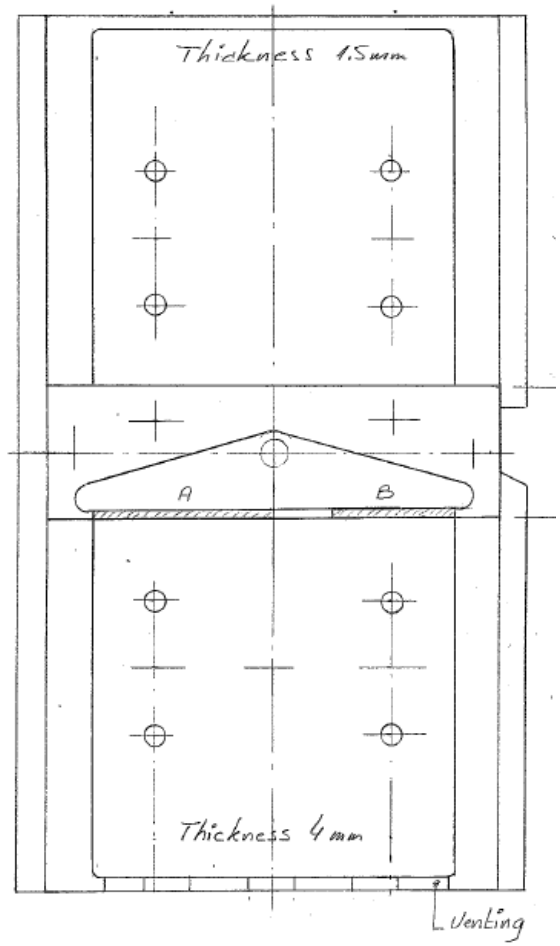
Unloading response

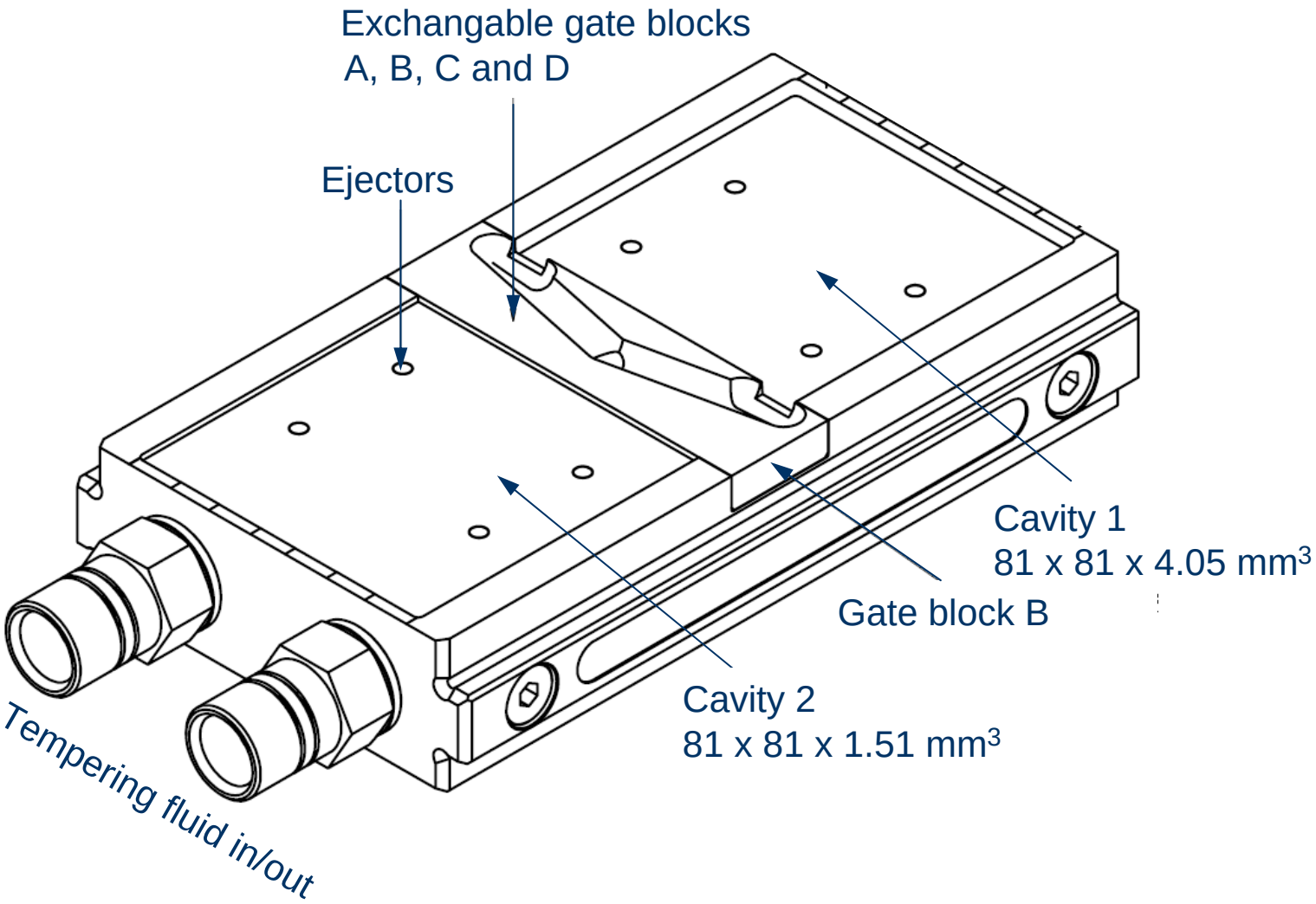


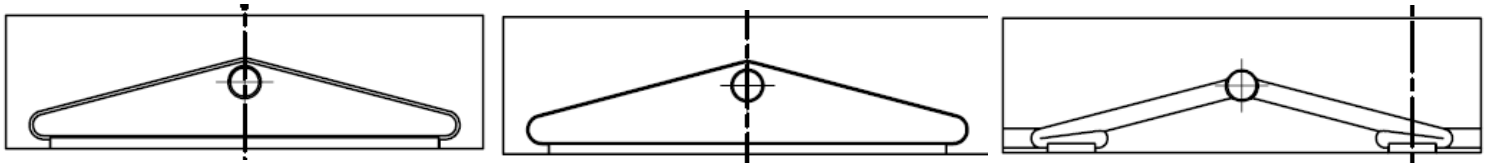
New mould for injection moulding test specimens

Partly funded by ISI

- 80 x 80 x 4 mm^3 plate
  - 80 x 10 x 4 mm^3 bars can be machined for
    - High-speed testing (ISO 18872, large strains)
    - Bending, Charpy etc
  - Other specimen geometries for shear, compression etc
  - Specimens can be cut parallell and perpendicular to flow
  - Exchangable gate inserts:
    - Film gate
    - Point gates at two corners (producing a weld line with varying strength)
- Also a cavity for a 80 x 80 x 1.5 mm^3 plate
- Combined pressure and temperature sensor in each cavity







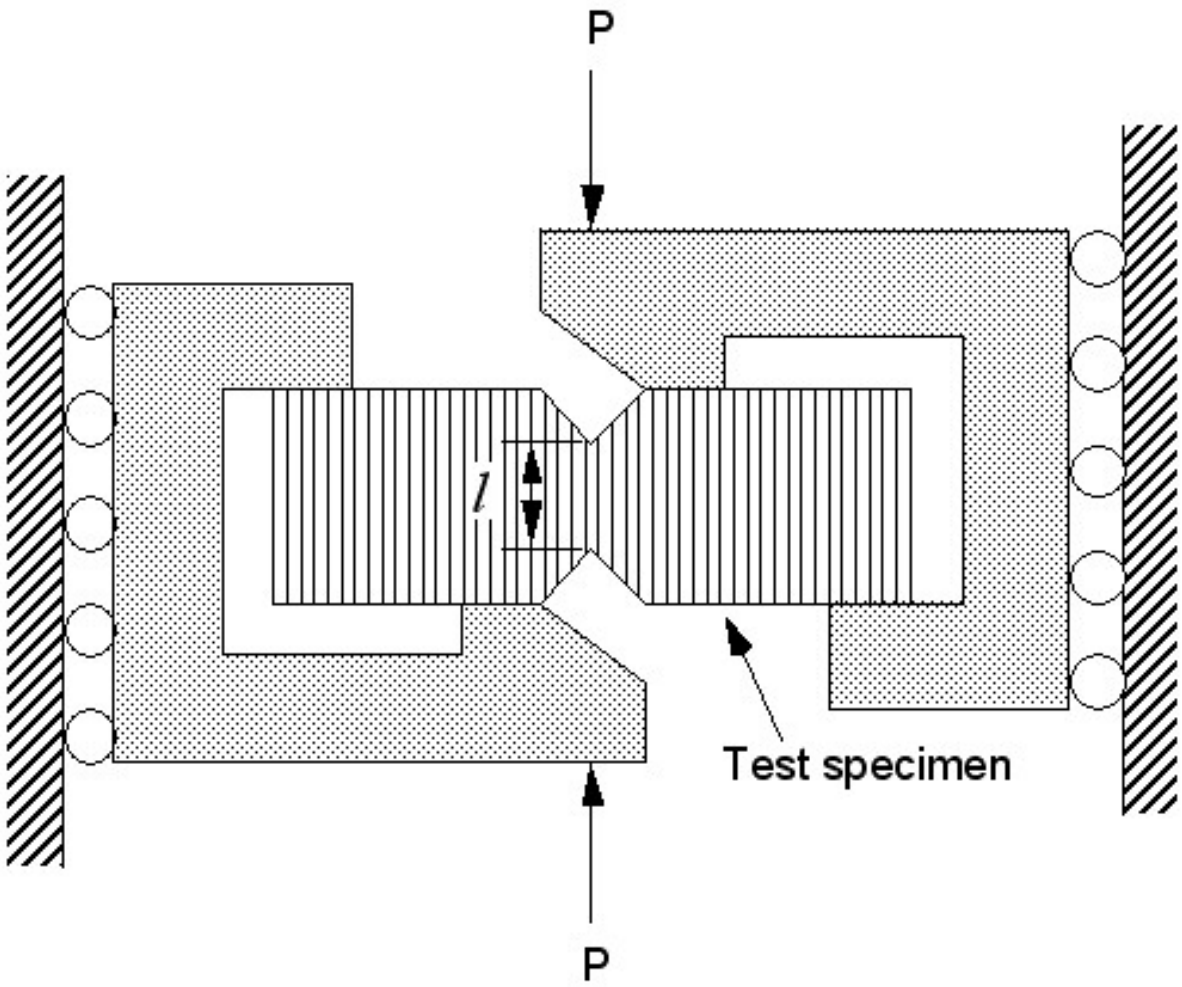
Gate block A for cavity 1 | Gate block C for cavity 2 | Gate block D for cavity 2

Small milling machine for making test specimens

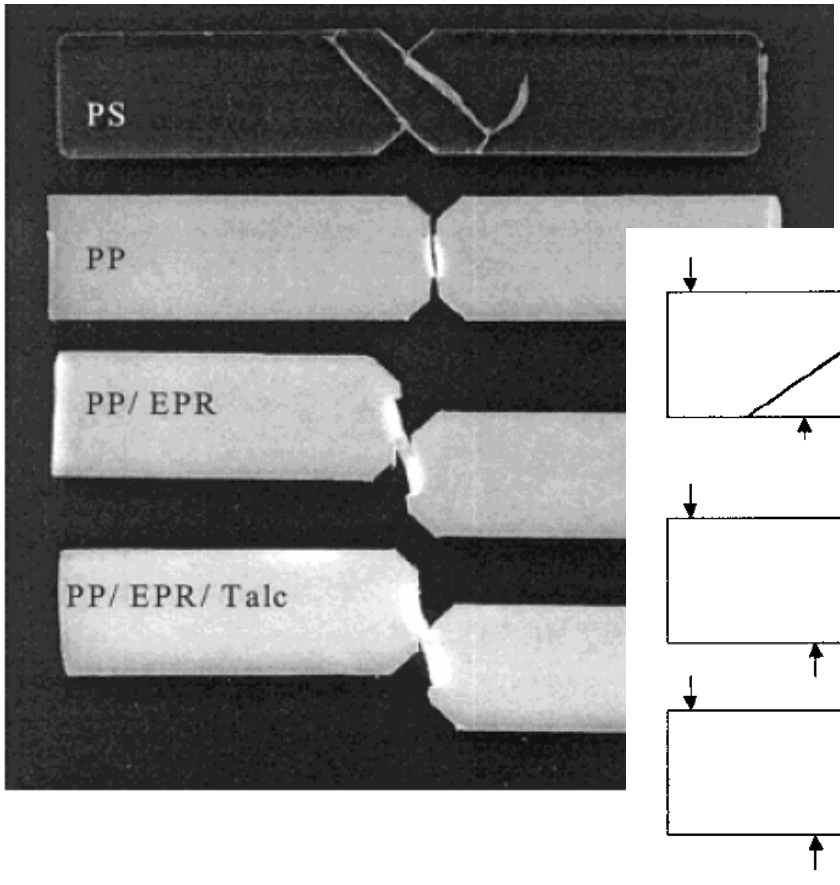
Partly funded by ISI

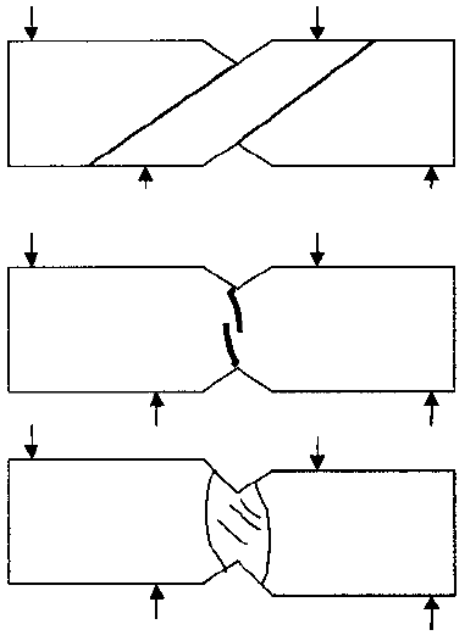
Shear etc

Iosipescu shear test (ASTM D 5379)



Iosipescu shear testing
(Xiang and Sue, J. Appl. Polym. Sci., 2001)





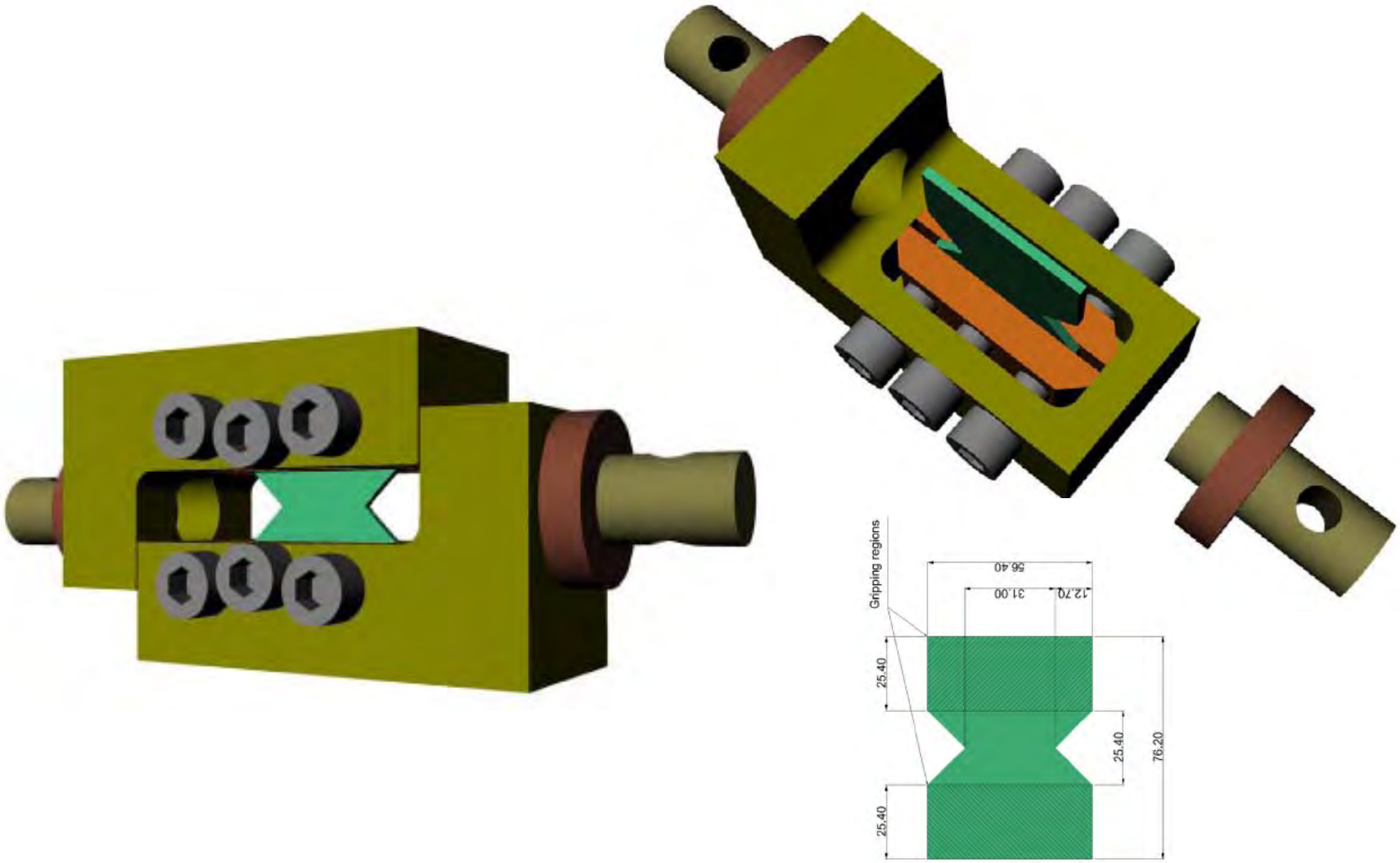
Failure under Mode I mode (e.g. PS)

Failure under Mode II mode (e.g. PP)

Stretching in the notched region
(e.g. PP/ EPR, PP/ EPR/ Talc)

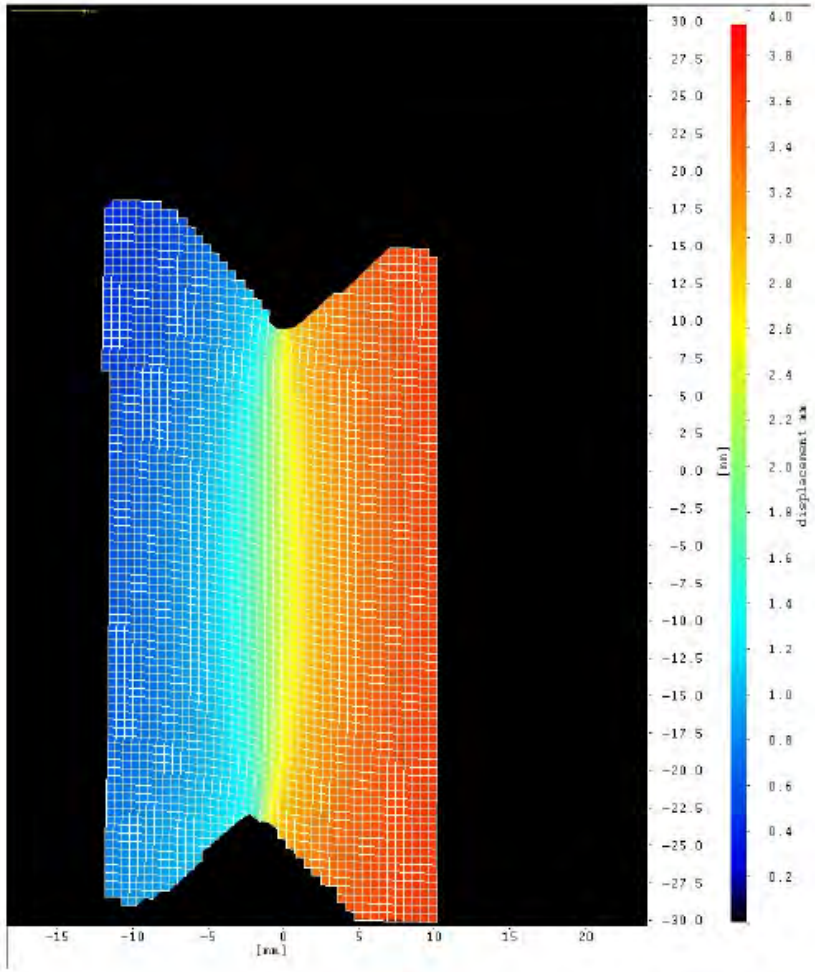
Effect of temperature?

V-notched rail shear test (ASTM D 7078)

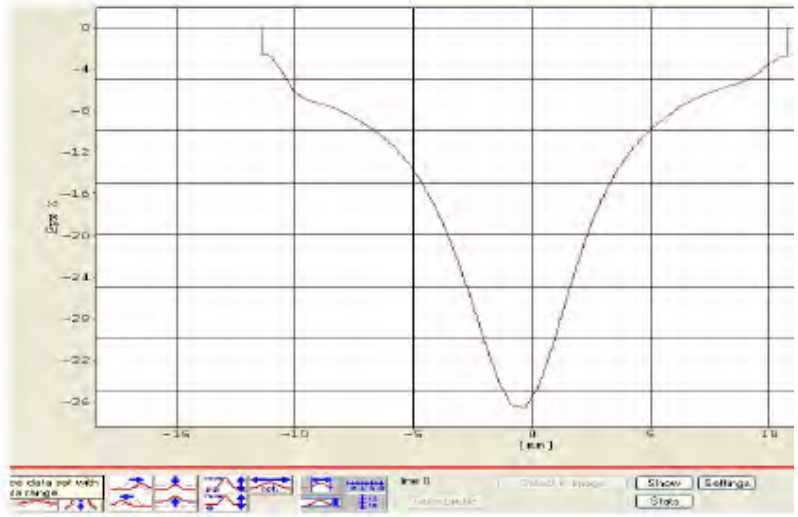


Digital image correlation

Full-field displacement and strain measurements



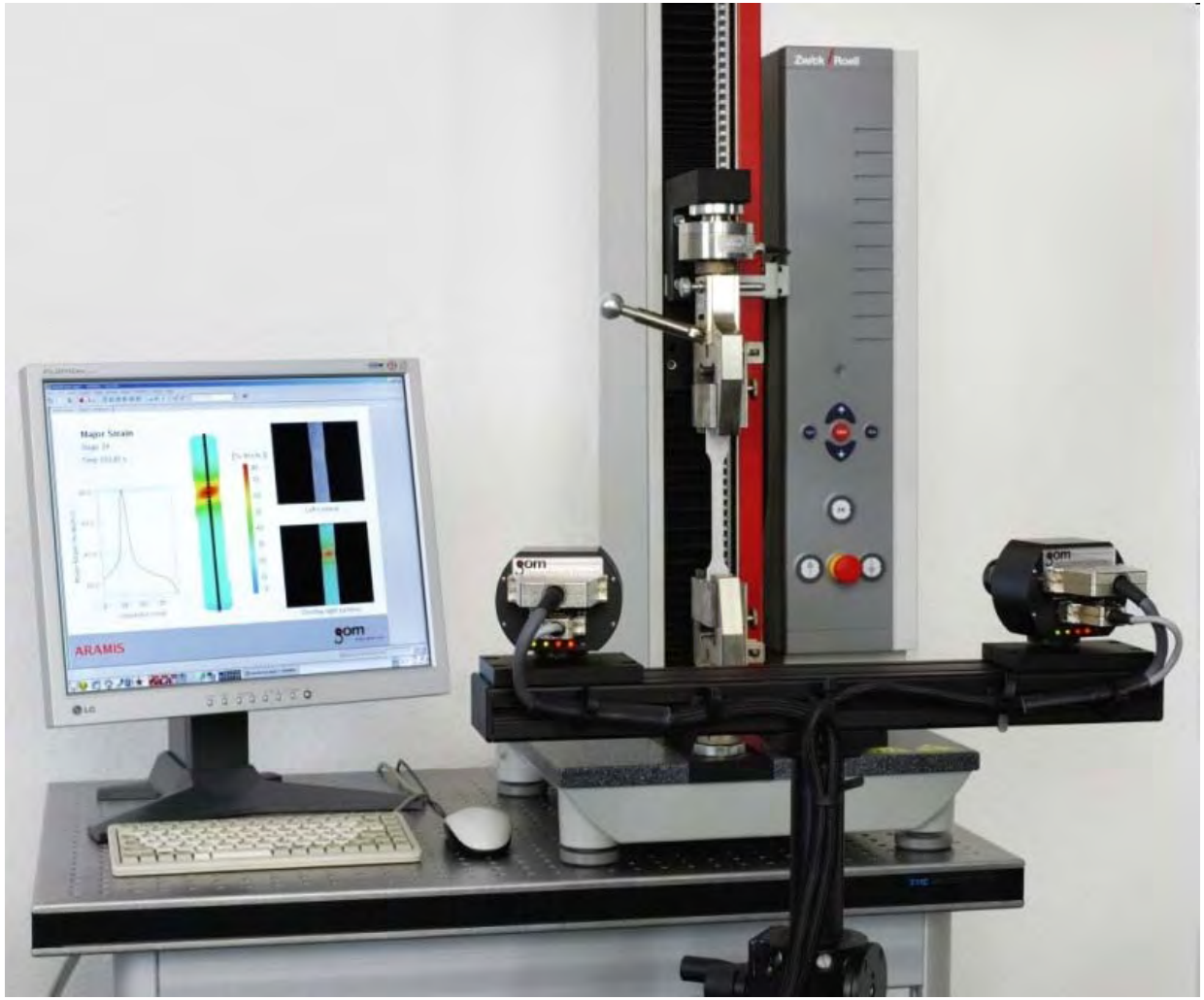
Vertical displacements



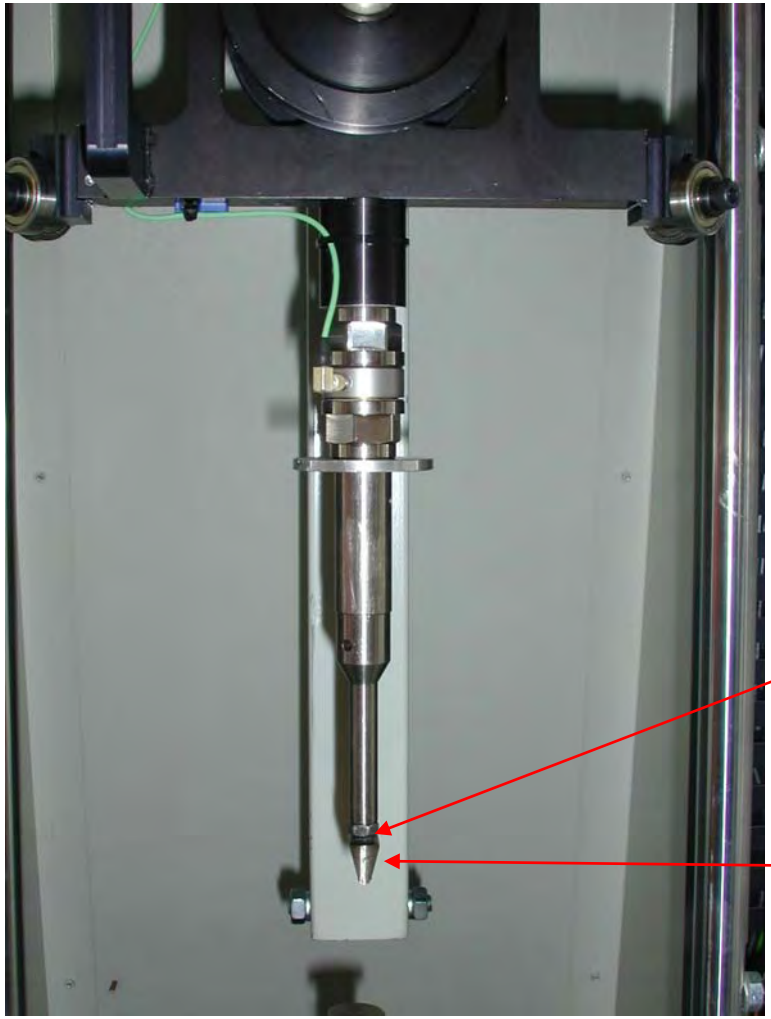
Shear strain distribution across specmen (horisontally)

3D digital image correlation

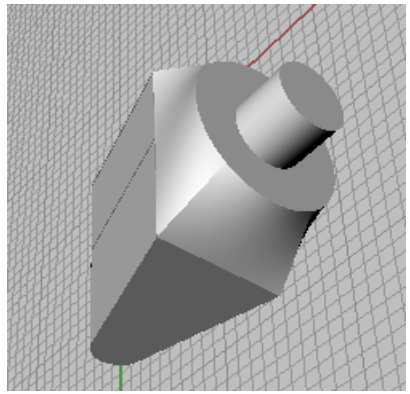
Equipment (hardware and software) will be bought by SINTEF (not funded by ISI)



New striker for 3-point bending impact test (work in progress)



- New force senssor (Kistler 9301B) will be mounted close to striker head
- New striker head and striker shaft of titanium alloy



PhD work

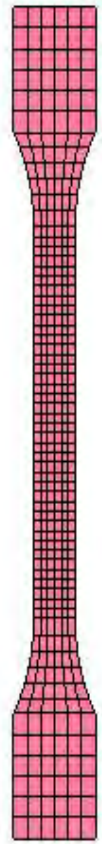
Main objective:

Development of improved material model(s) for impact loading

- Injection moulded parts, with and without fibre reinforcement
- Testing and numerical simulation (LS-DYNA)

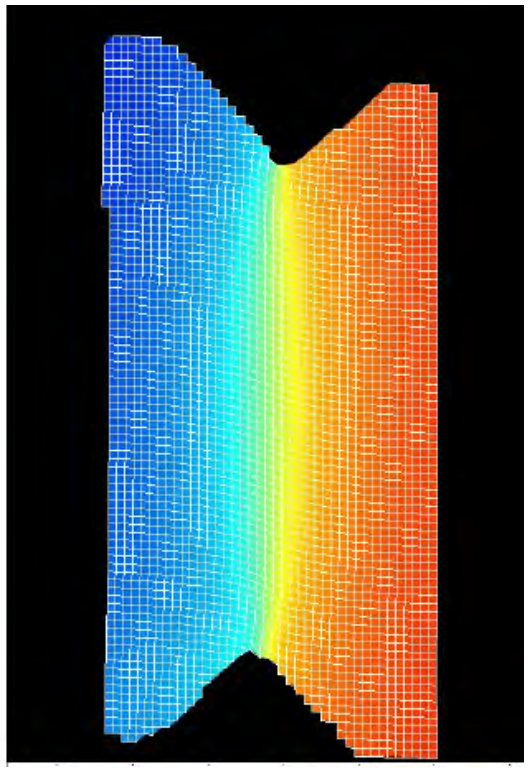
Suggested topics:

- Improve test procedures
  - True stress-strain for tension, compression and shear
  - Reliable data from testing of components
- Improve or develop material models, and establish robust simulation methods
- In-depth study of deformation, damage and fracture
  - Material type (MWD etc), recycling
  - Loading temperature
  - State of stress (tension/compression, multiaxial, ...)
  - Process-induced anisotropy and inhomogeneity
    – Numerical simulation of injection moulding to get input for local mechanical properties to LS-DYNA



Summary

- Various tests (high-speed tension, shear, compression) in development for obtaining better input to material models
- Digital image correlation for full-field strain measurements
- New mould for assessing processing effects, anisotropy etc
- PhD student



Background info

Expertise of the Polymer and Composites group
In the field "mechanical response"

- Knowledge of the characteristics of different polymer materials
- Competence on the micro-mechanics (yield, fracture) of some polymer materials
  - Effects of morphology/processing
  - Characterisation by microscopy etc
- Experience with testing polymers
  - Instruments designed/modified for polymers (high-speed tensile tester, instrumented falling weight)
  - Special rigs, instrumentation
  - Special tests for composites
- Some experience with numerical simulation (mainly ANSYS)

Equipment for mechanical testing

- Zwick – quasistatic (load cells 10 N – 250 kN, up to 0.5 m/min)
- Schenk Trebel – quasistatic (100 kN, temp. from -150 to 250 °C)
- Instron – fatigue (250 kN)
- Schenk/Instron – high-speed tensile testing (up to 10 m/s) and fatigue (100 kN, but also possibilities for other load cells)
- Imatek/Rosand – Instrumented dart drop (up to 12 m/s, up to 650 J)

Mechanical testing (cont.)

- Autoclaves for chemical and thermal exposure, pressure testing etc
- Dynamic mechanical thermal analysis (DMTA)
- Mini tensile tester (can be placed in a microscope)
- Rig for creep testing (under development)
- Measurement of linear thermal expansion
- Expertise on strain gauges and logging
- Experience with high-speed video