

Evaluating the long-term strength of polyethylene by using the Strain Hardening Test



Kiwa Technology

**Trust
Quality
Progress**



SHT: Strain Hardening Test

Smart assessment of PE pipe material



- Fast
- Suitable for all PE types
- Less material needed

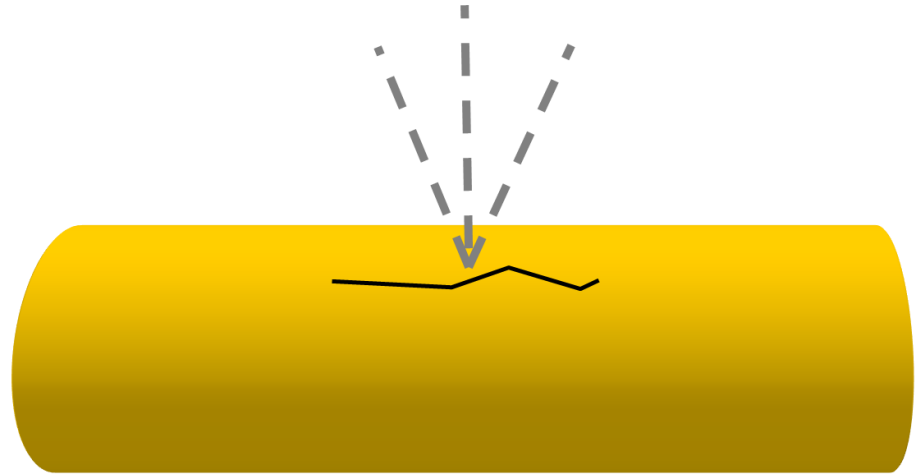
Lifetime performance of pressurised PE Pipes

Main failure mechanism

- Slow Crack Growth (SCG)

Classic tests: accelerated SCG

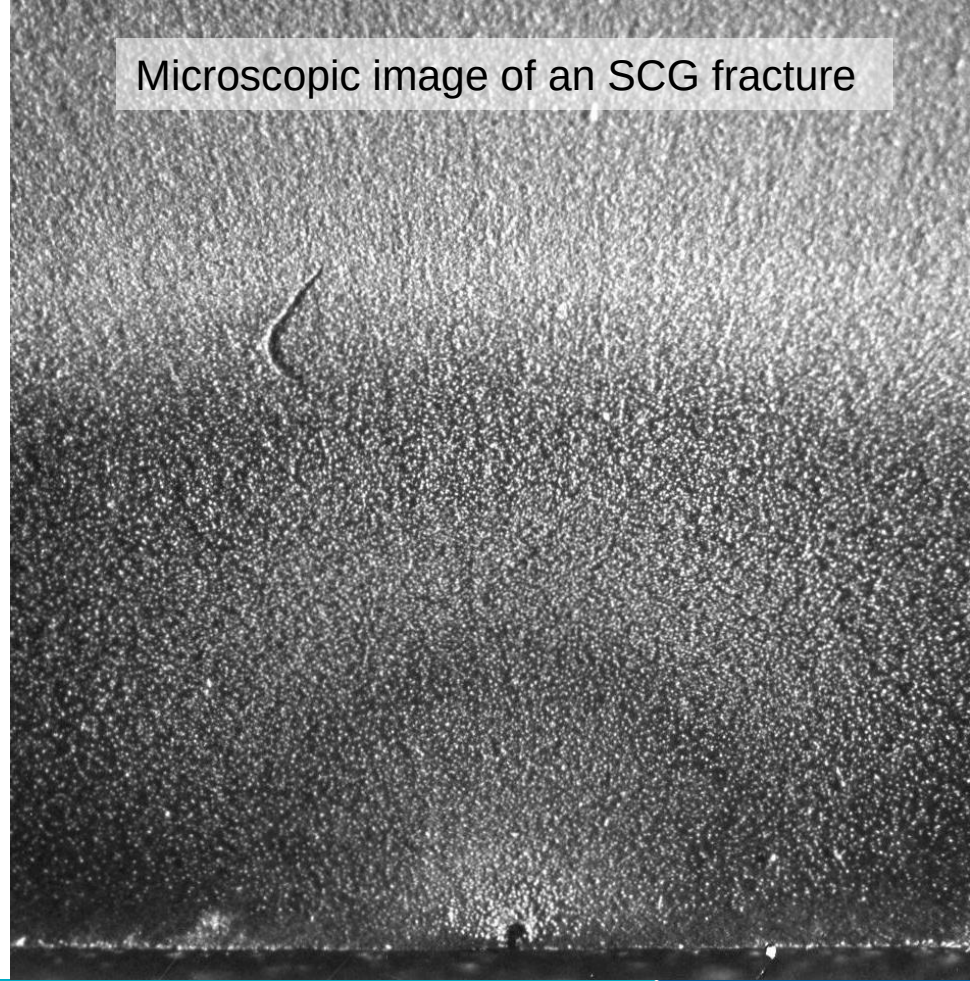
- Higher temperatures
- Detergent
- Notches



SCG explained

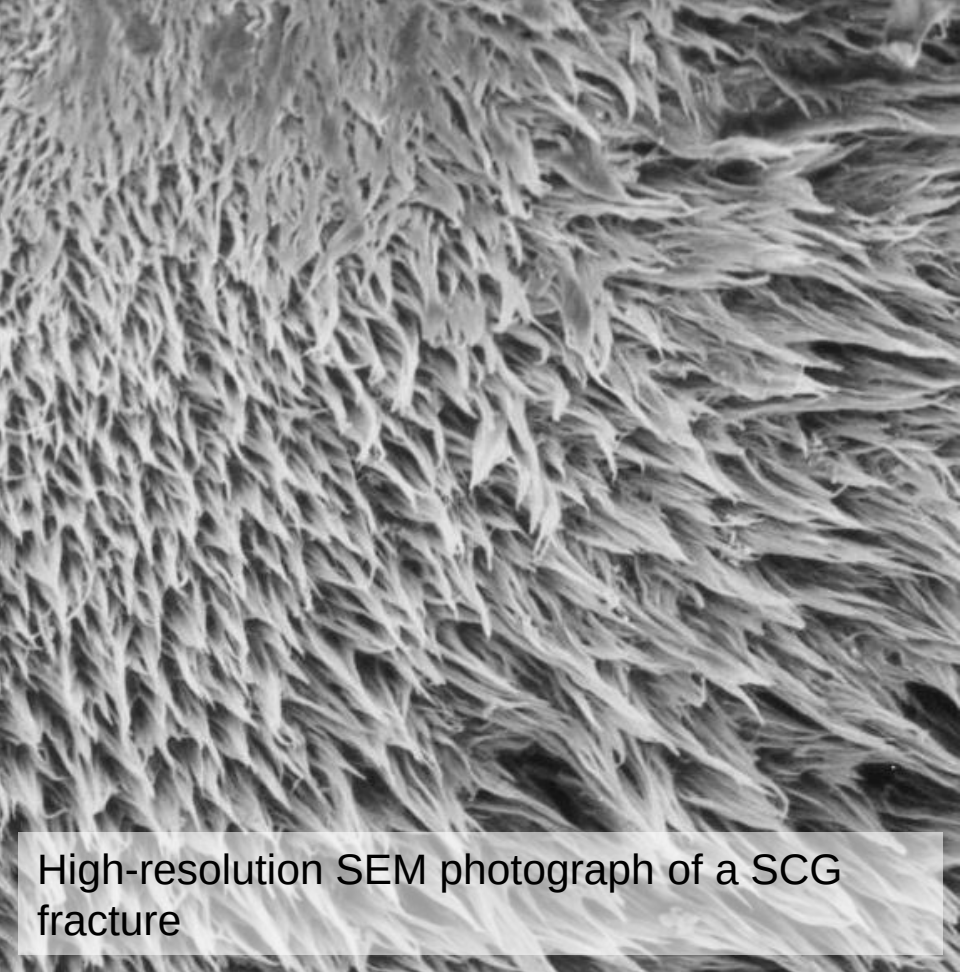
‘Brittle’ SCG fracture surface

Microscopic image of an SCG fracture



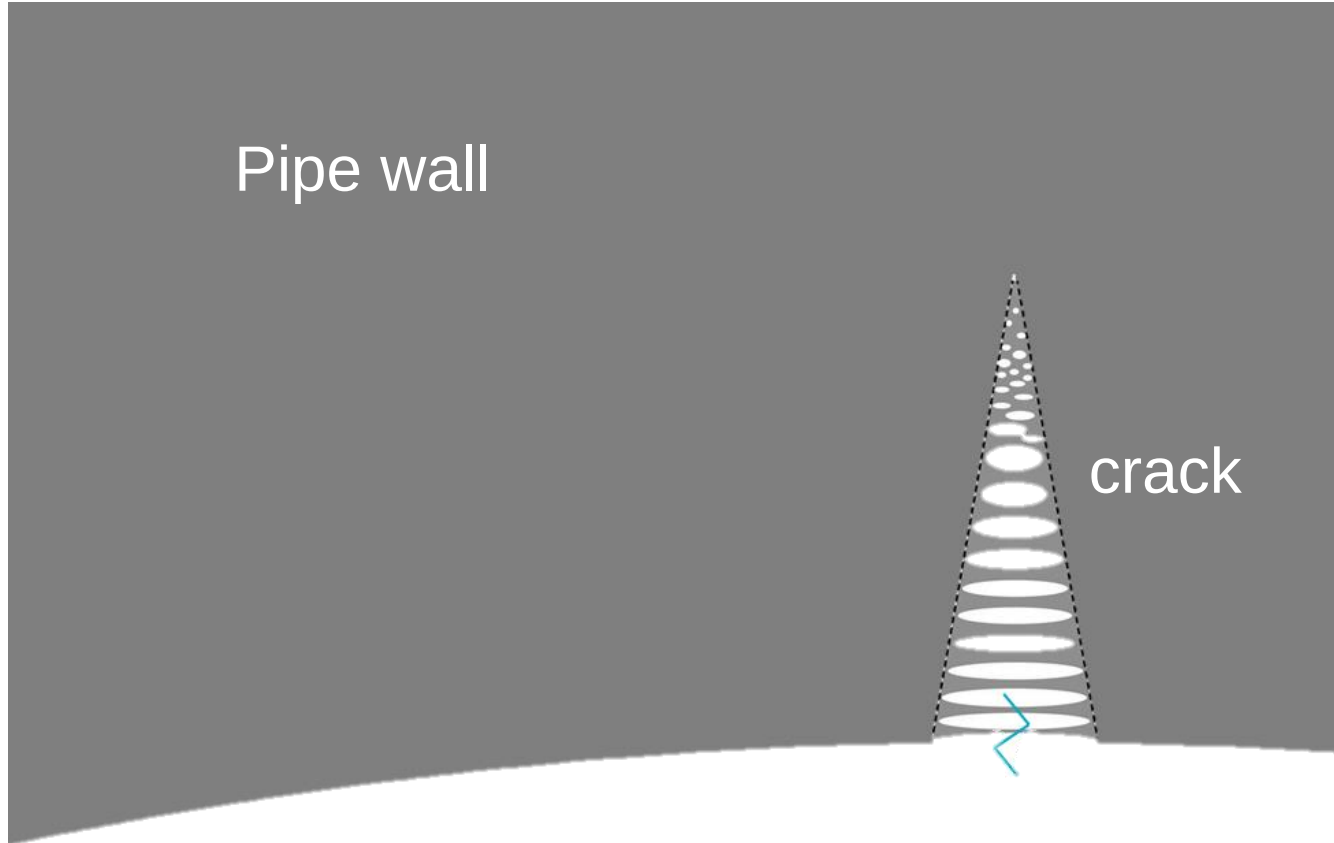
A closer look

- Fibrils
 - Stretched and broken

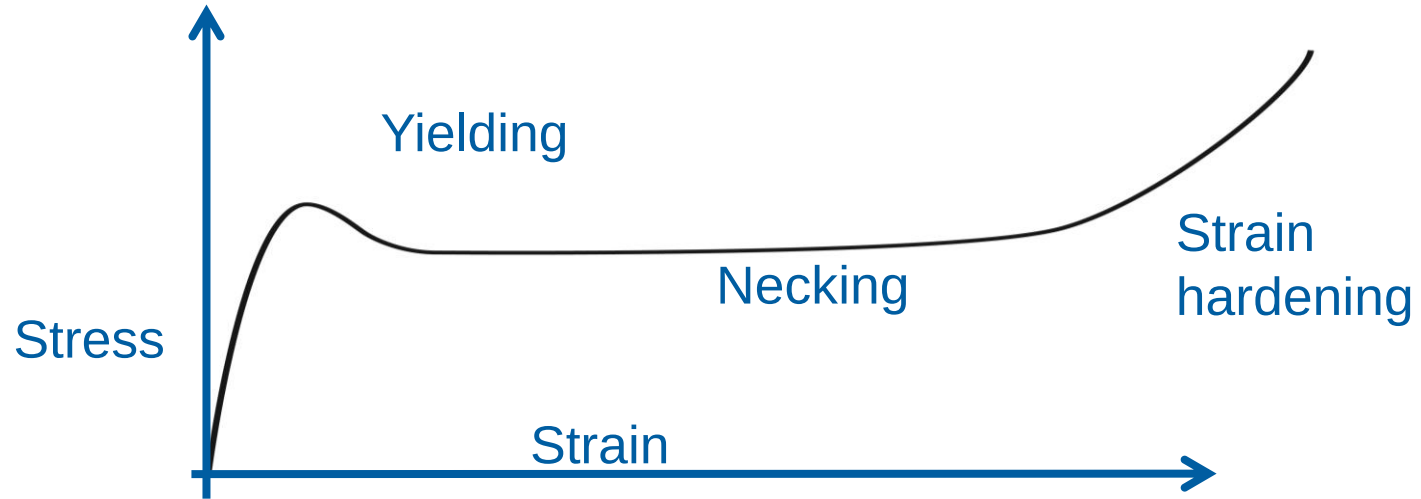


High-resolution SEM photograph of a SCG fracture

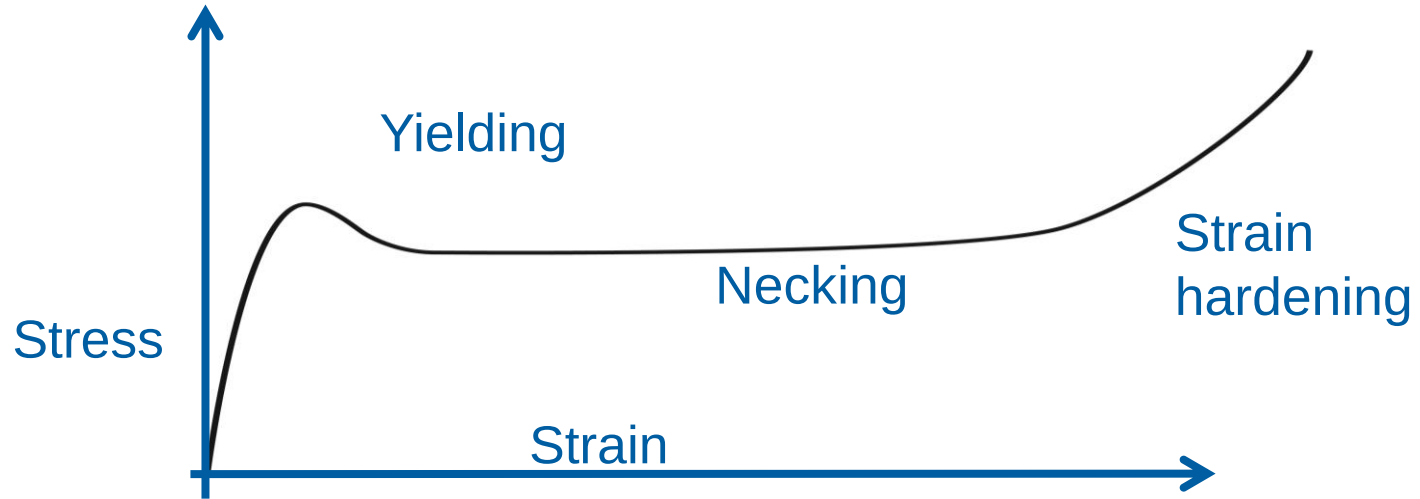
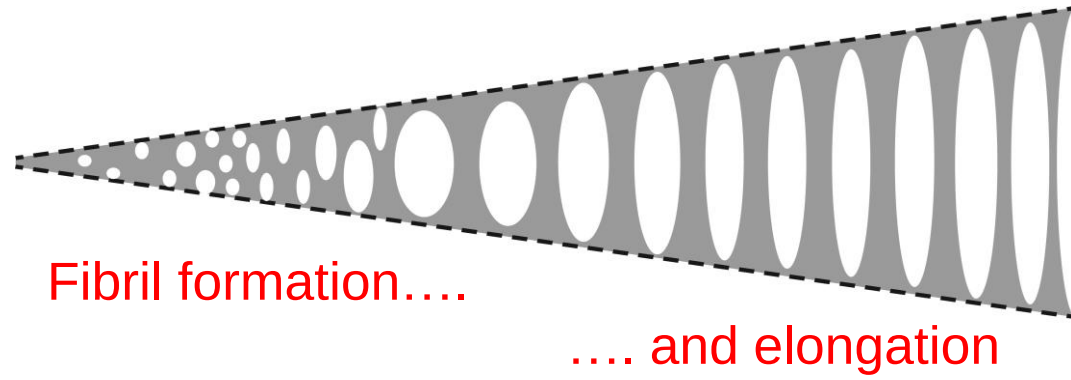
Schematic view of SCG



Tensile test curve for PE



Theory



Strain Hardening Test Method

INTERNATIONAL
STANDARD

**ISO
18488**

First edition
2015-09-01

~10 gram



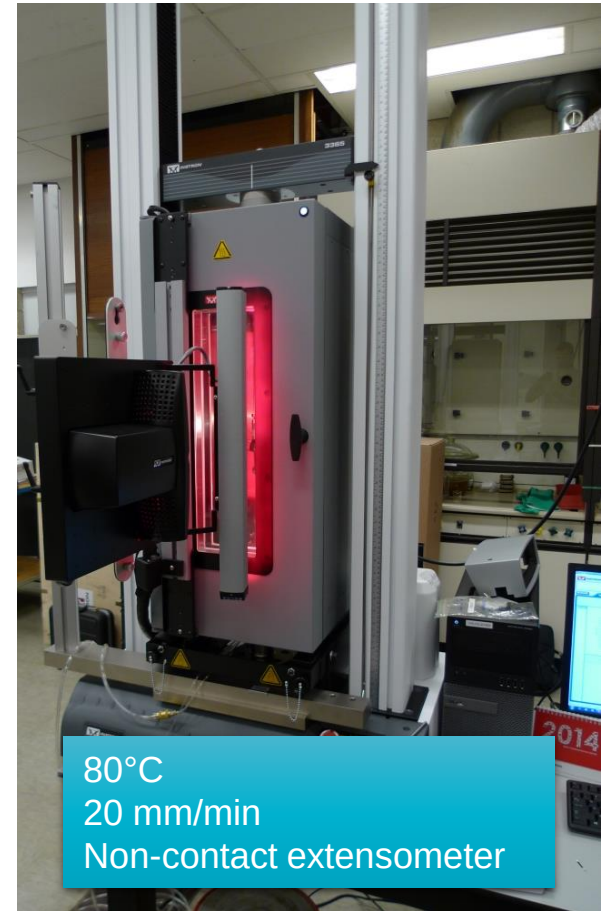
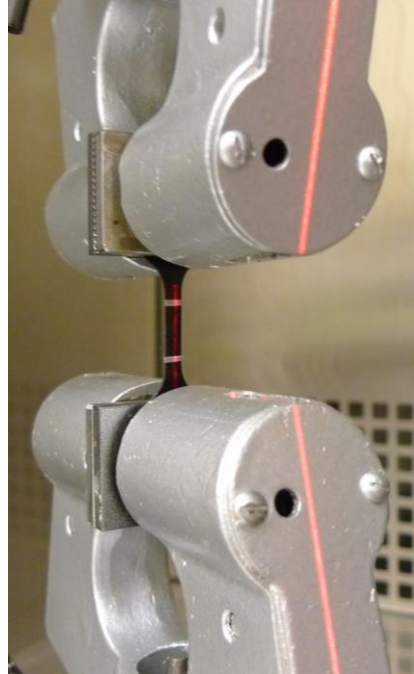
0,30 mm or 1,0 mm thick



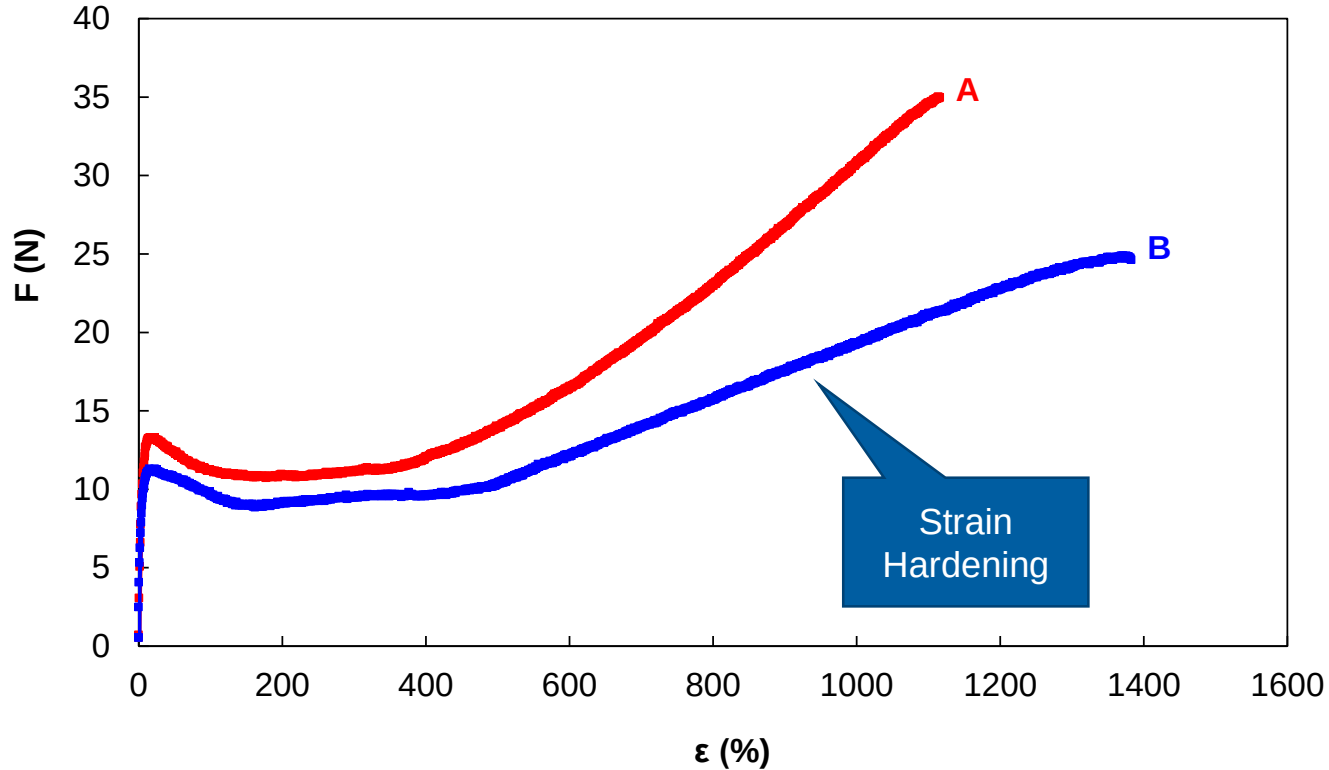
Strain Hardening Test Method

Tensile test

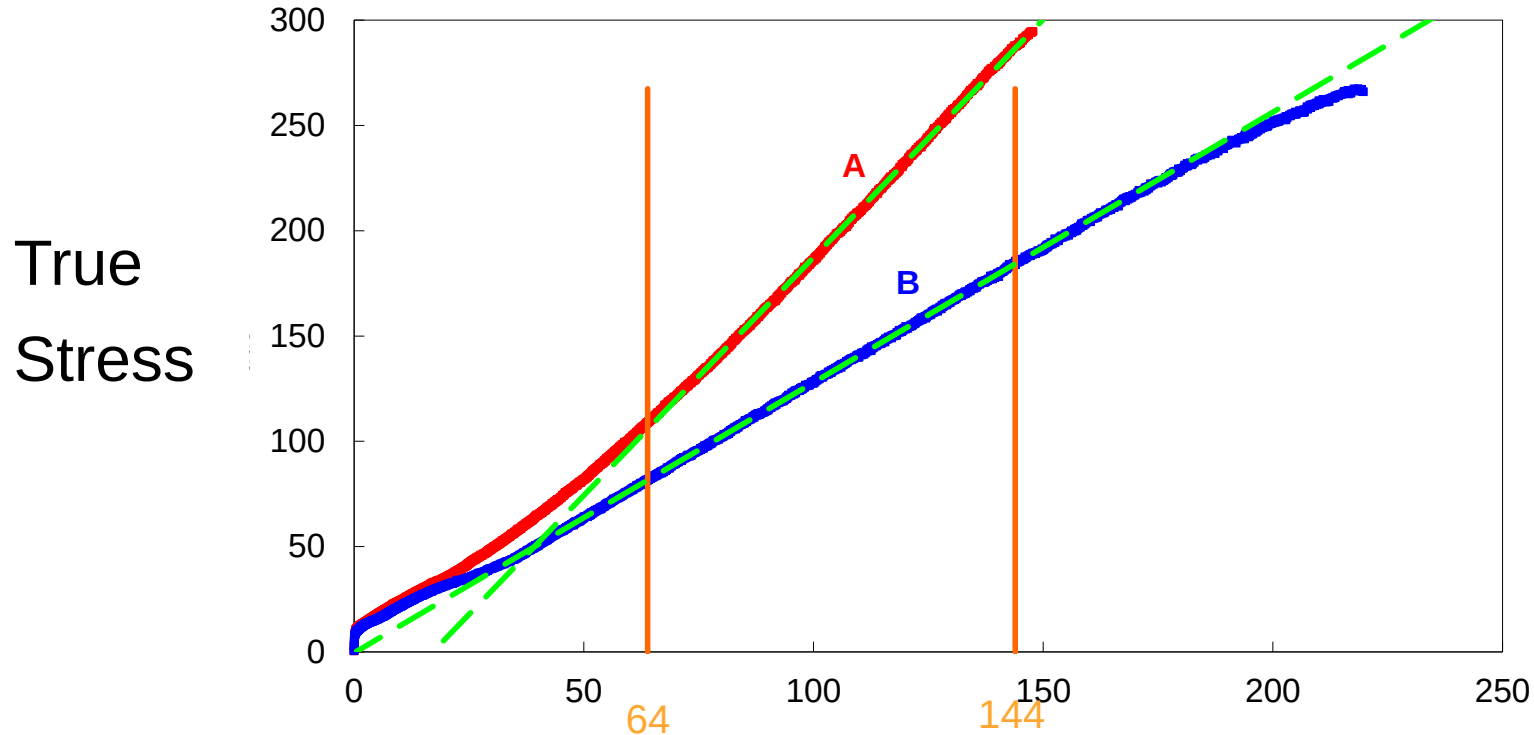
- Elevated temperature
- Precise elongation measurement



Initial curve for two materials

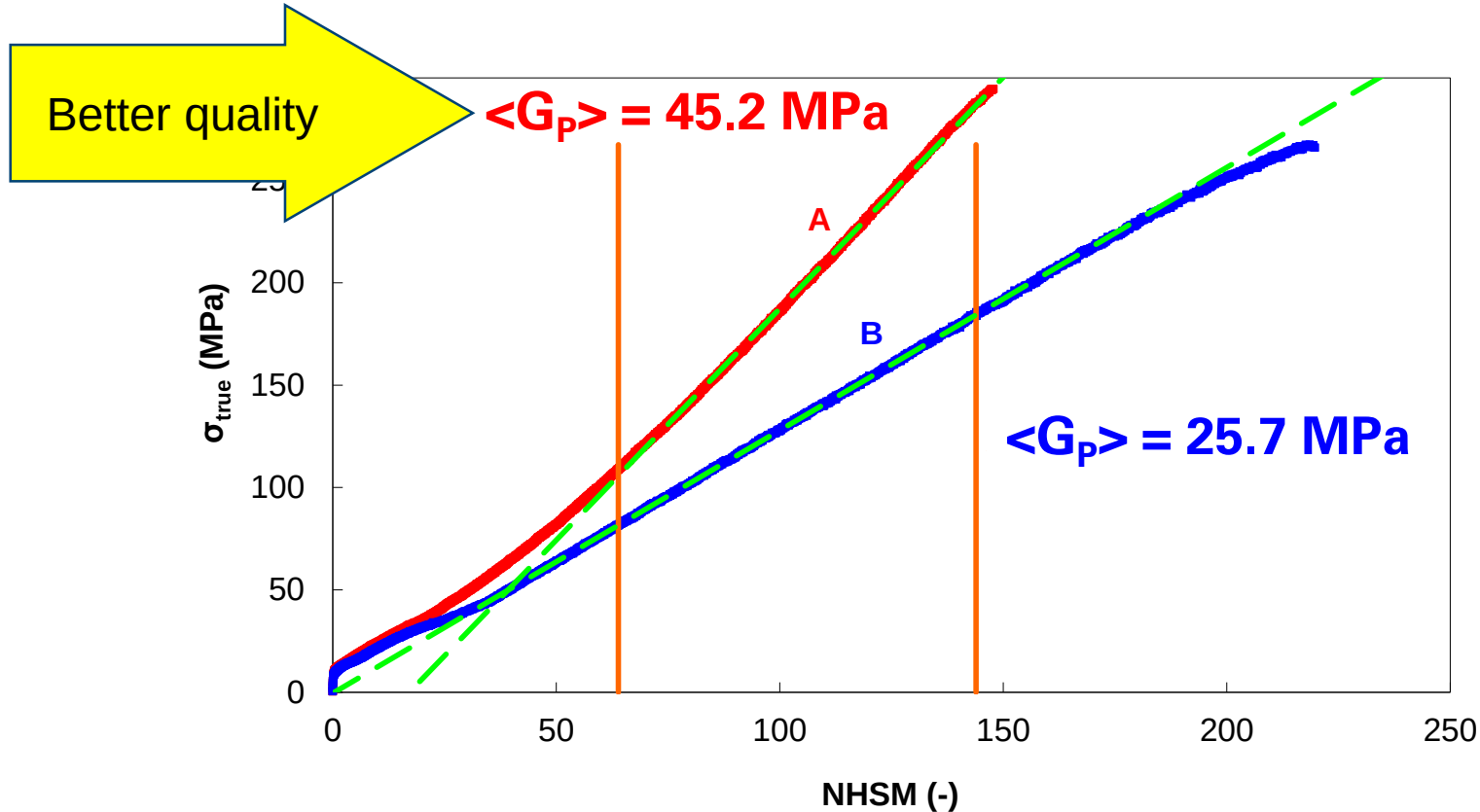


True stress – true strain curve

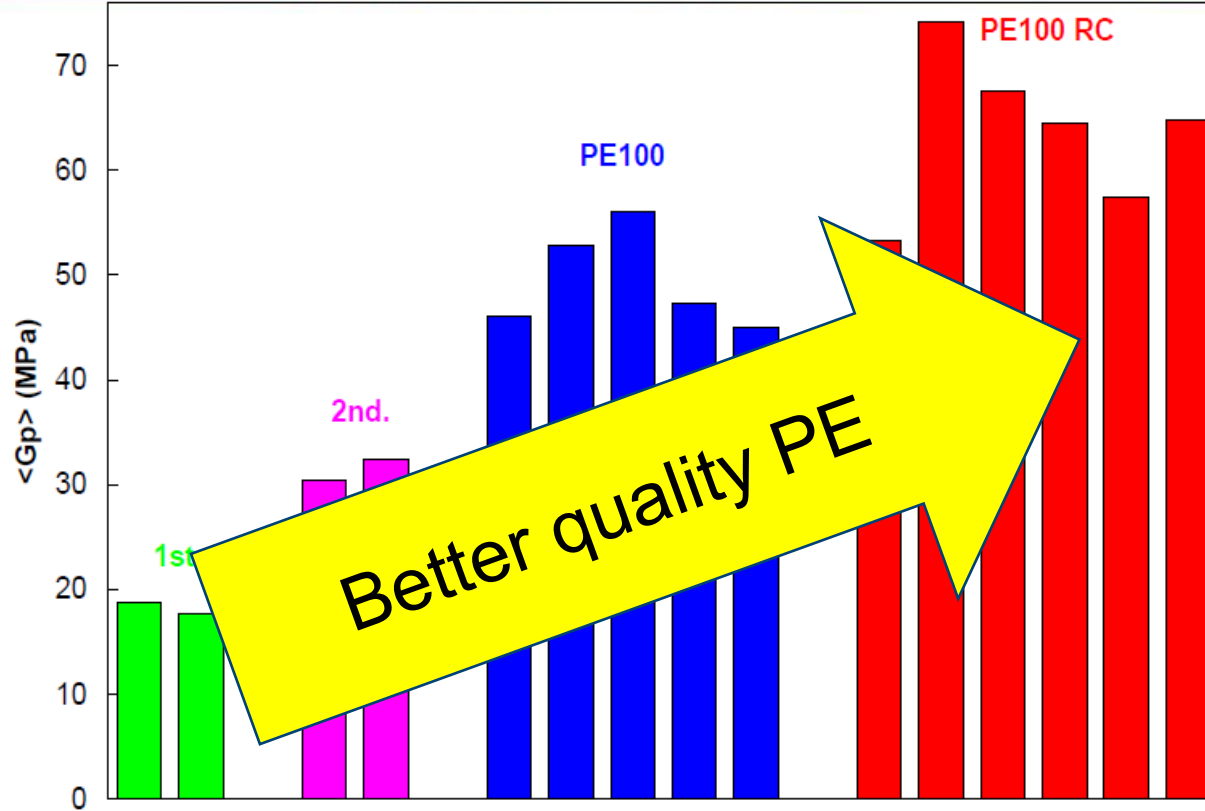


Neo Hookean Strain Measure

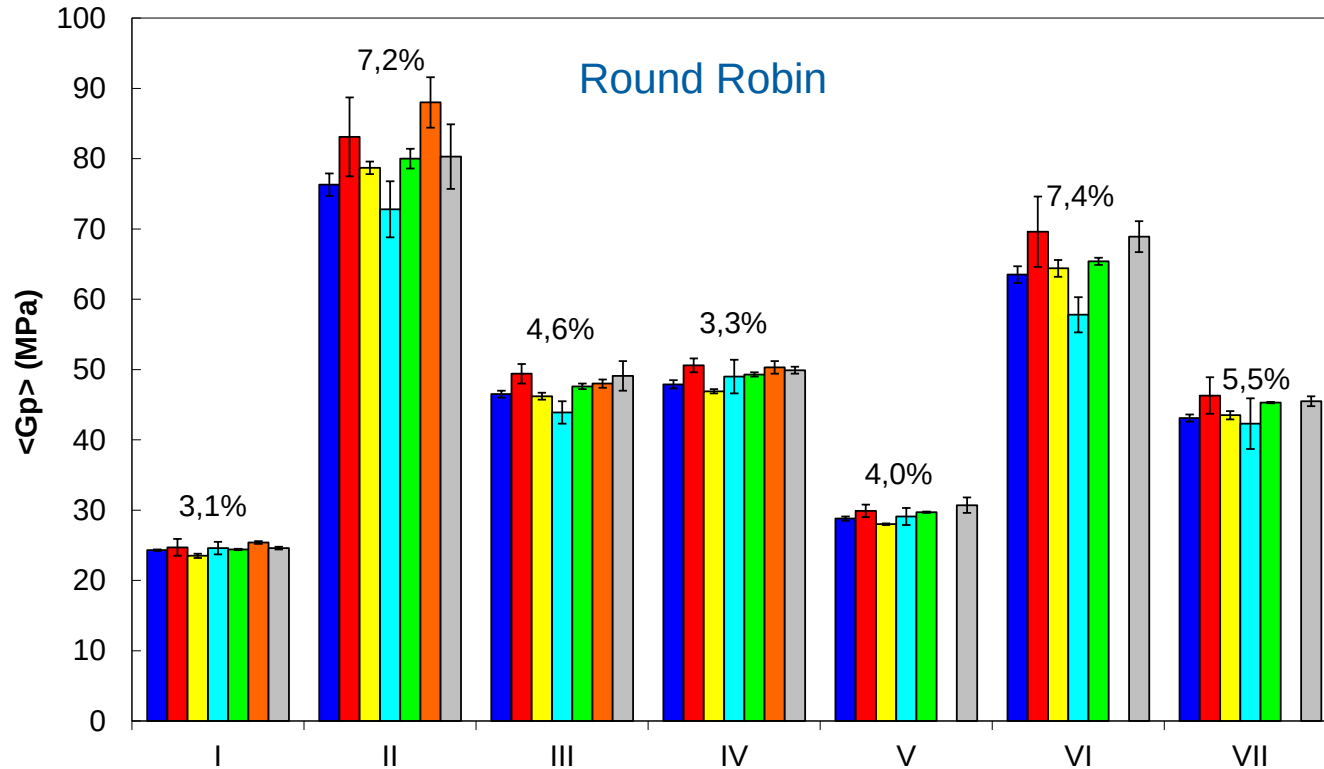
Strain hardening modulus $\langle G_p \rangle$



Different types of PE



Consistent results

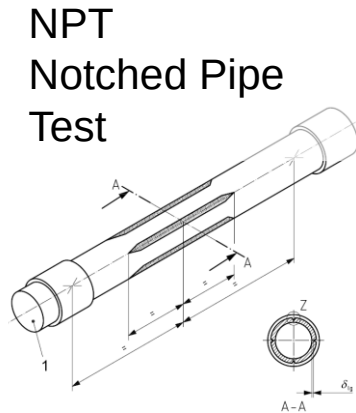
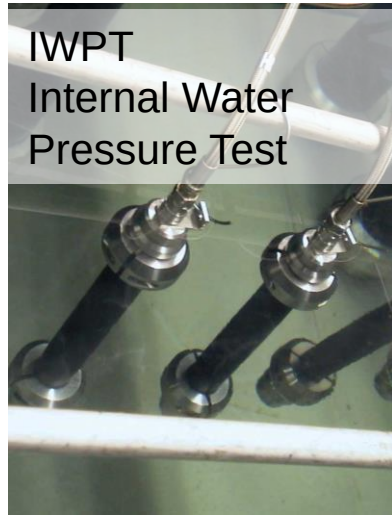


E.J.W. van der Stok, F.L. Scholten, *Two Complementary Tests to Determine The Quality Of PE 100-RC*, Plastic Pipes XVII, Chicago, 2014.

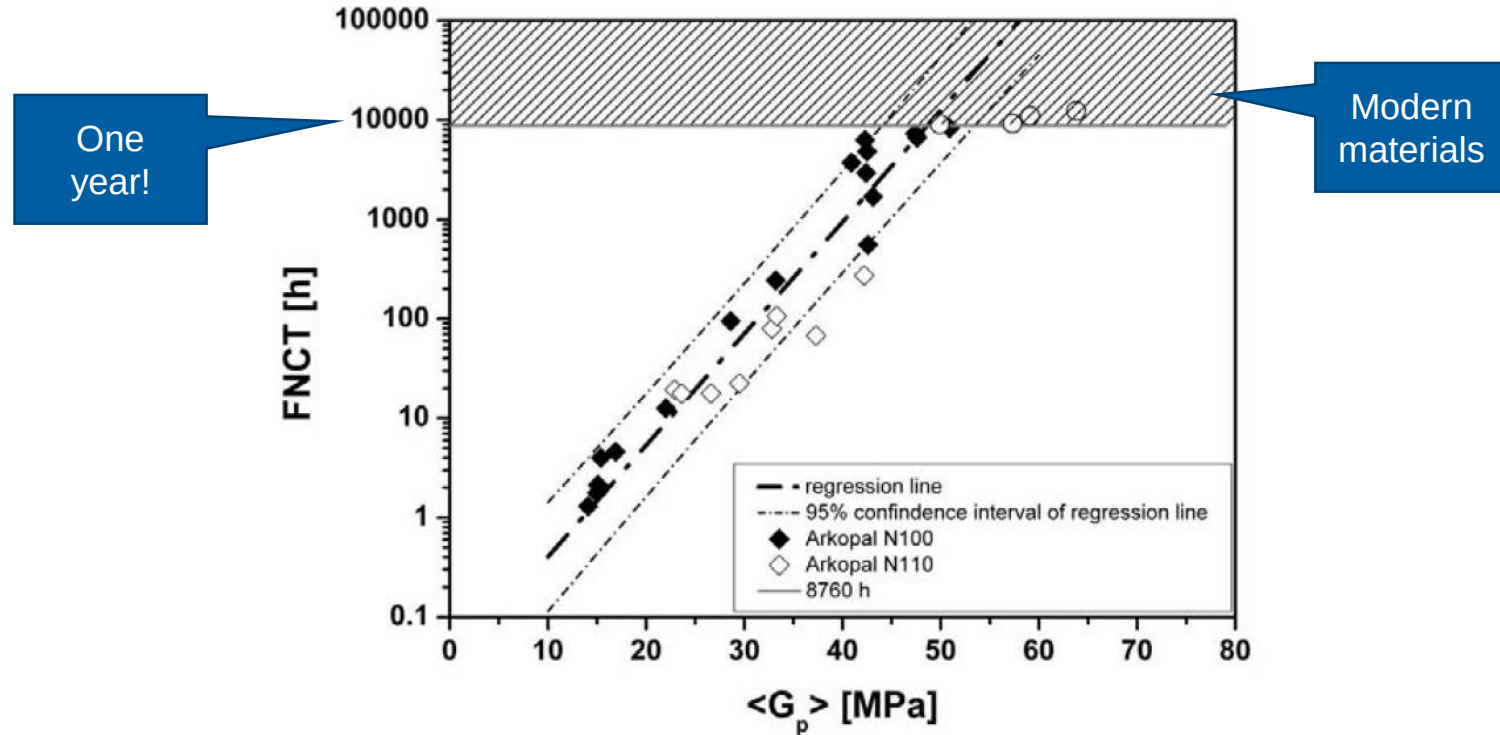
Classic way of testing

Accelerated SCG

- Time consuming
- Not suitable for all materials



SHT correlates well with classic tests



D.J.M. Havermans - van Beek, R. Deblieck, M. McCarthy, R. Kloth, L. Kurelec, *An Elegant and Fast Method to Predict the Slow Crack Growth Behaviour of High Density Polyethylene Pipe Materials*, Plastic Pipes **XV**, Vancouver, 2010

The Strain Hardening Test

- Fast
- Suitable for all PE types
- Less material
- Low interlaboratory scatter
- Good correlations with traditional tests



More information

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Kiwa Technology – *material research*

- ☐ Product development
- ☐ Determination of material quality
- ☐ Failure analysis
- ☐ Exit Assessment program

