DSM Introduction
DoDyNet

WP5 & ESR 9

DSM Material Science Centre

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Mission

- Our purpose is to create brighter lives for people today and generations to come
- We connect our unique competences in Life Sciences and Materials Sciences to create solutions that nourish, protect and improve performance

DSM
BRIGHT SCIENCE. BRIGHTER LIVING.

History based on science & innovation

DSM (1902)

Energy, chemistry & polymer technology

Materials Sciences

Gist-Brocades (1869)

Biotechnology

Life Sciences

Hoffman La Roche's Vitamins (1930s)

Chemical synthesis & biotechnology

Food
Feed
Personal Care

Vitamins & Minerals
Omega's & Carotenoids
Premixes food & feed
Enzymes, Cultures & Yeasts
Nutraceuticals
Pharmaceuticals

Materials

High Performance Plastics
Coating Resins
Functional Materials
Super strong fibers
Biomedical materials
Bio-plastics

Green Energy

Advanced solar
Cellulosic bioethanol

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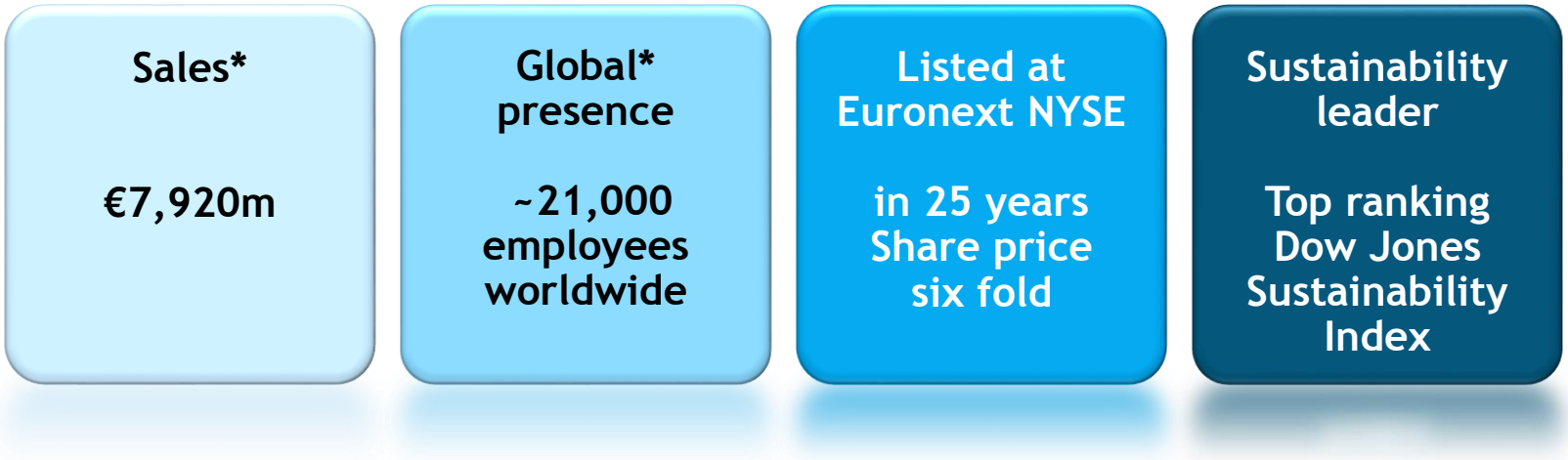
DSM at a glance (2016)



- DSM is a global sciences based company active in health, nutrition and materials
- DSM delivers innovative solutions that nourish, protect and improve performance in global markets such as food and dietary supplements, personal care, feed, medical devices, automotive, paints, electrical & electronics, life protection, alternative energy and bio-based materials

* Excluding 2016 pro-forma and pro-rata (annualized) sales (€1,445m) & number of employees (ultimo 2016) of non-consolidated Associates & Joint Ventures (for sales this is mainly Patheon, DSM Sinochem Pharmaceuticals and ChemicalInvest)

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Research & Development at DSM

Ensures DSM's excellence in Material & Life Science competences

Creates innovative solutions for business problems by applying both fundamental & conceptual knowledge

Scientific approach to industrial problems

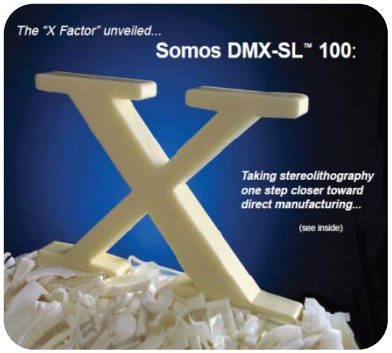
DSM Materials Science Center:
3 research centers, ~300 people

Spanning chemistry, characterization, technology, processing and properties

Example DSM materials

Engineering plastics

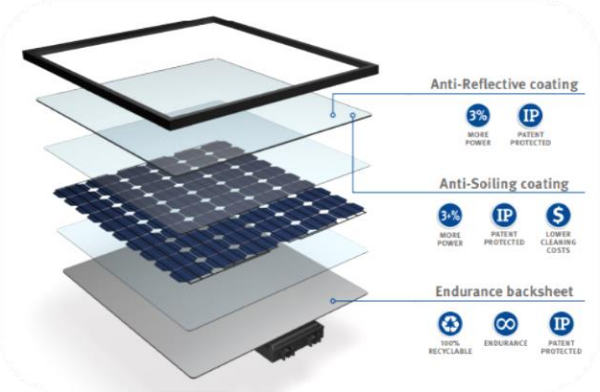
UV-curable materials



DSM Dyneema

Innovative resins

Solar



Arnitel® markets

Automotive

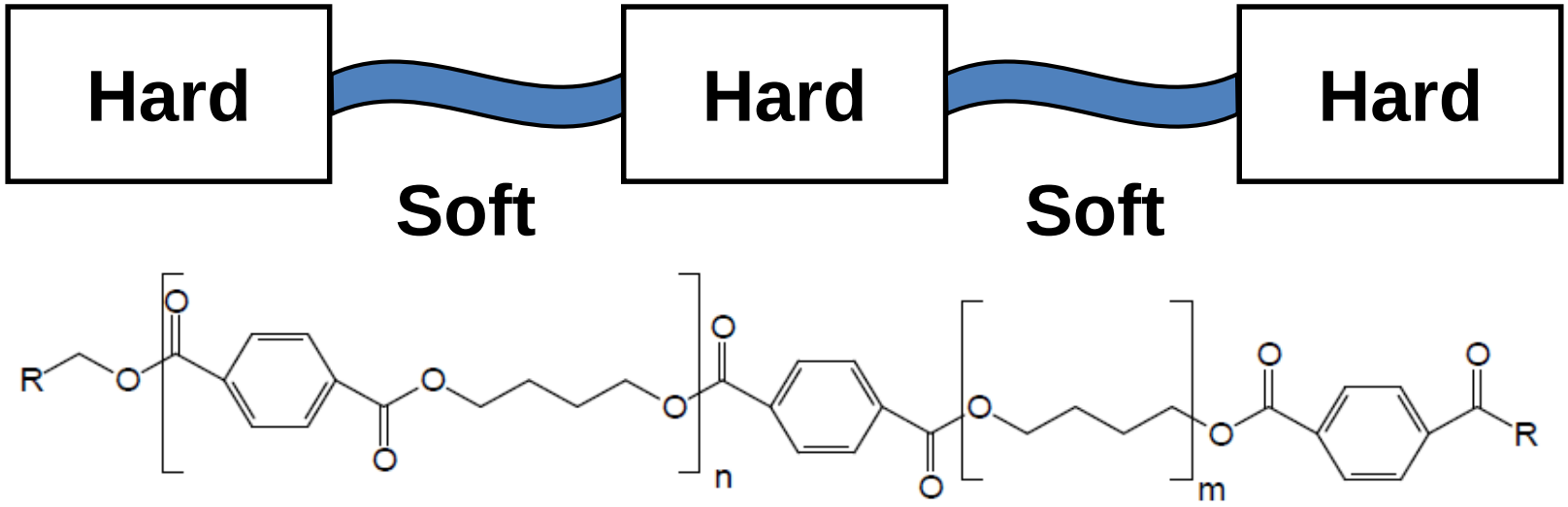
Electrical & Electronics

Flexible food Packaging

Consumer goods

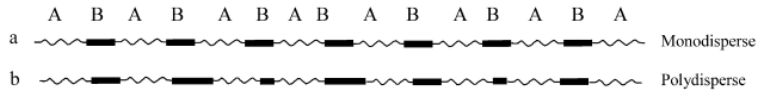
Furniture

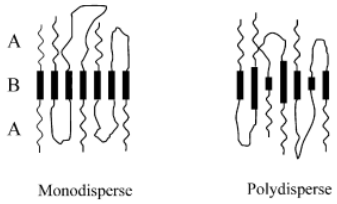
What is Arnitel®



Chemical Structure of a typical grade of Arnitel®

Arnitels® are single dynamic, physically cross-linked networks
Note the PBT blocks are polydisperse





Gaymans, 2011

TPE target applications

TPEs applications (construction, cables, packaging):

- TPEs combine melt-processability with softness & elasticity, recyclability

- Develop new thermoplastic DD elastomers from polyester-based TPEs from DSM (trade name Arnitel®), and investigate their rheological/mechanical properties.

The goal is to improve extensibility, and hence resistance to fracture at intermediate temperatures. Improved resistance to repetitive loading, scratches and compression set/creep are also desirable.

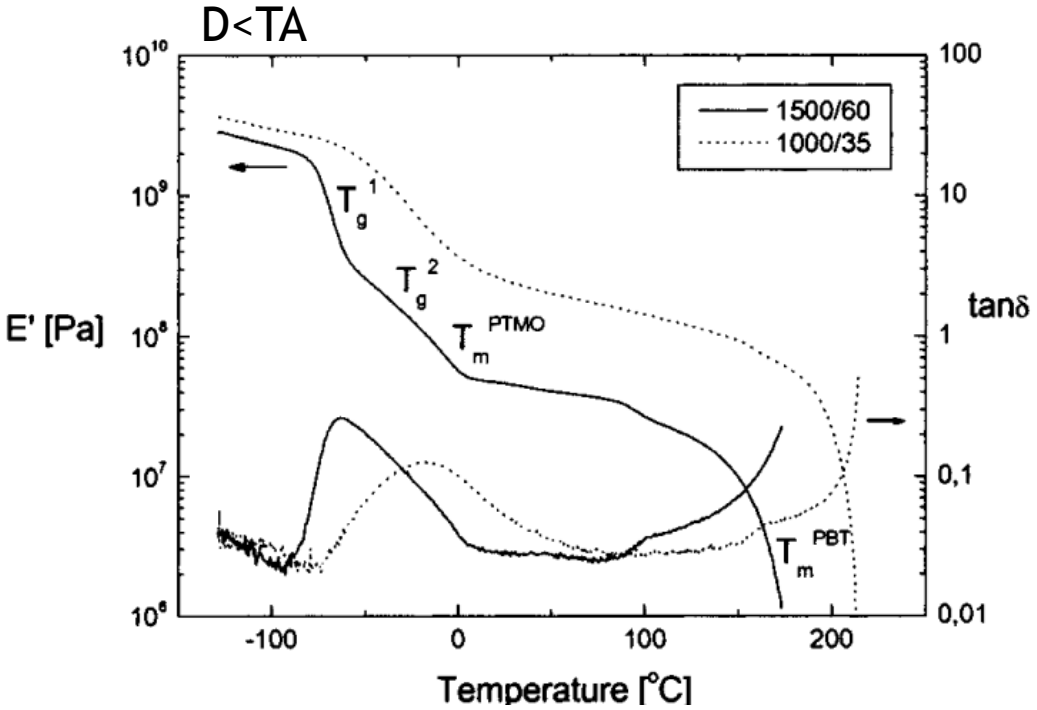
TPE challenges

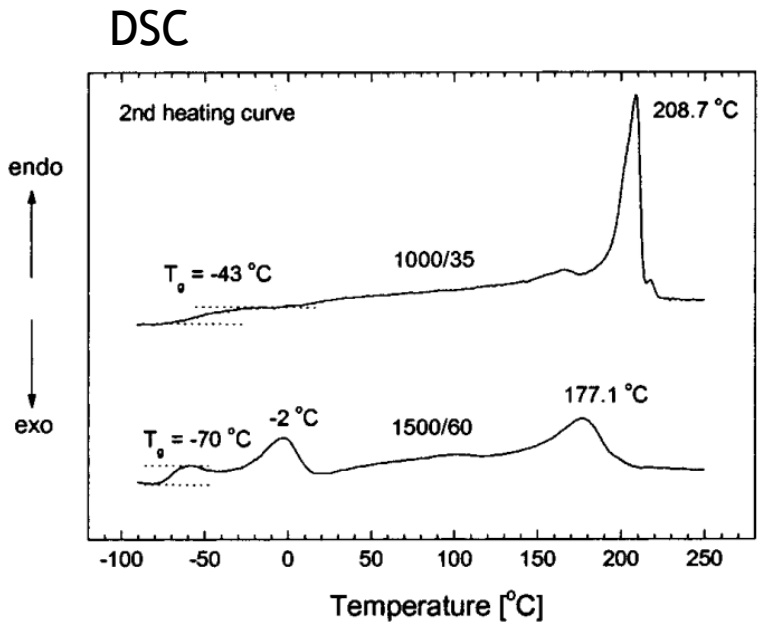
- DSM in interested in thermoplastic elastomers (TPUs, copolyesters, etc) and soft networks / gels for a wide range of applications.

Generic challenges for these physical networks include:

- The balance between mechanical performance and flow
- Maintaining mechanical properties across a wide temperature range (strain, creep performance)

Thermal behavior of PBT-PTMO copolymers

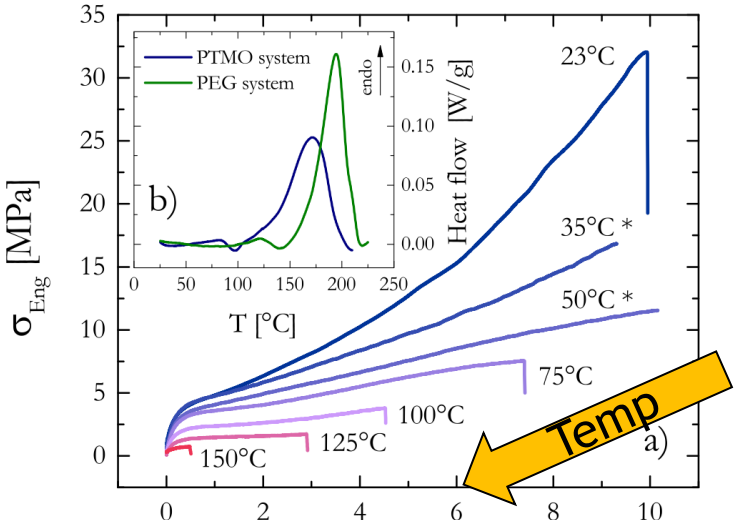


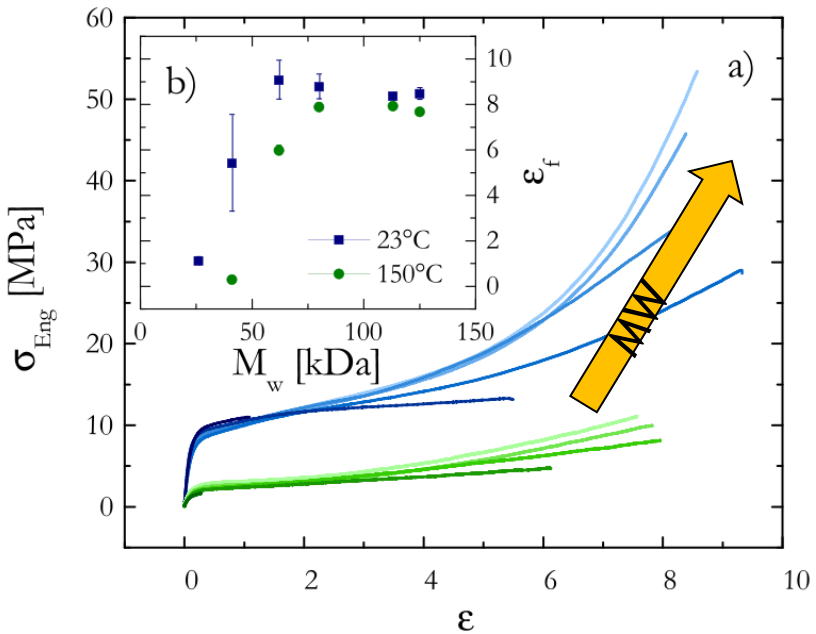


- Well-defined melting behavior and wide rubber plateau

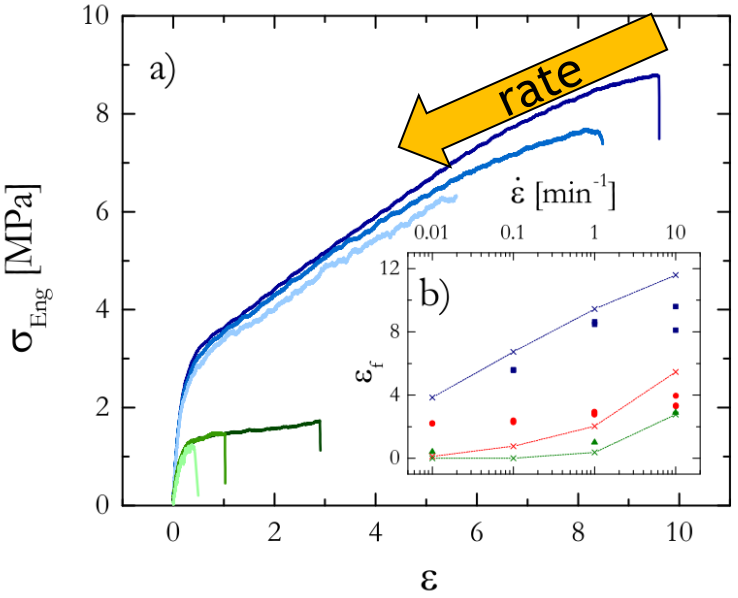
Gabrielse, Macromolecules 2001

Traditional TPEs show strong temperature and rate dependence



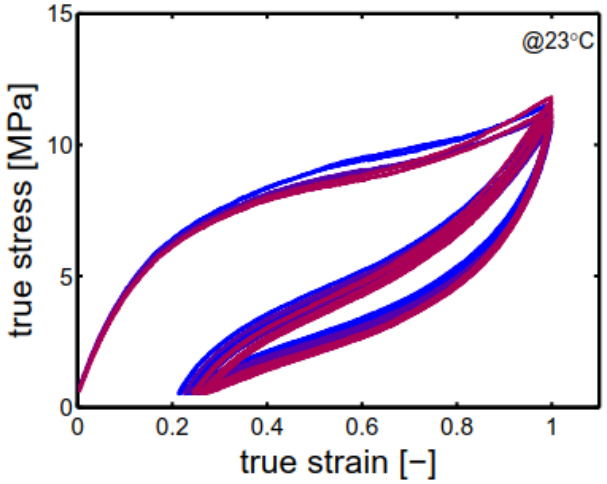


- Tensile strains for soft TPEs show strong dependency on:
  - Temperature
  - MW
  - Strain rate

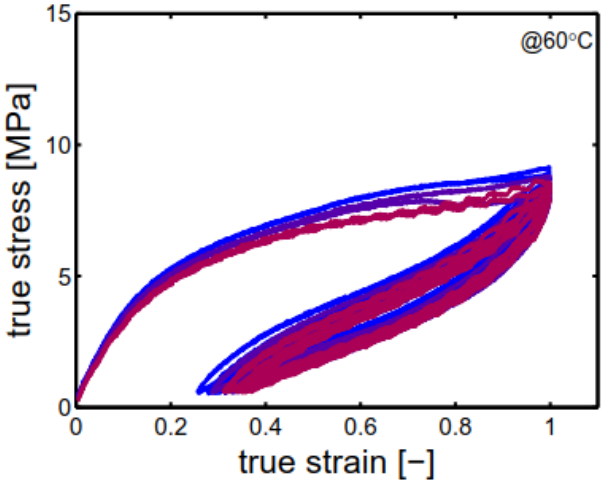


Aime, Eisenmenger, Engels, J. Rheology, 2017.

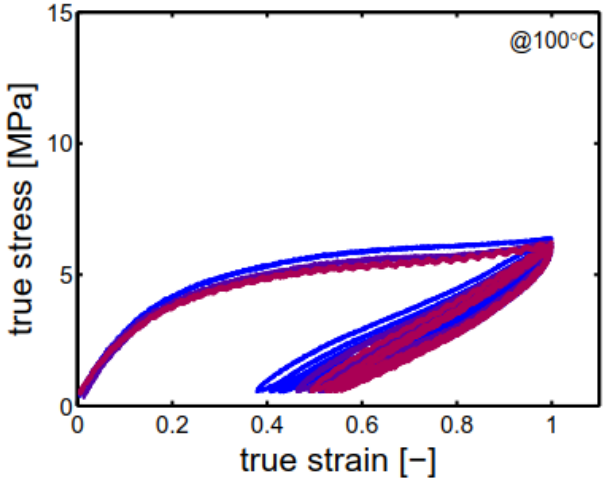
Cyclic loading behavior of TPEs



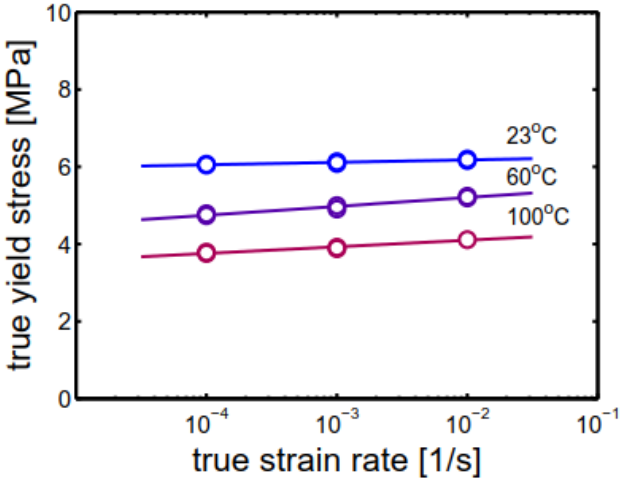
(a) E60 23°C



(b) E60 60°C



(c) E60 100°C



(d) E60 rate dependence.
Solid lines are lineair fits.

Mark Kanters, Internship report DSM_Tu/E

WP5: Application properties and product design

- **WP5 – Application properties and product design:**
  - **(i) identify the relevant properties for the target industrial applications**
  - (ii) determine the structure and composition of specific DDNs in order to obtain these properties
  - (iii) select the appropriate synthesis scheme in order to produce such DDNs in large amount
  - (iv) test and validate these ideas and concepts.
  -

ESR 9:

- First 3 years working at DSM, final year at UCL

- **ESR9**:
  - **Tensile and compression behavior** DDNs at DSM
  - Developing statistical models for network properties (UCL)
  - aim to build a global physical picture on the origin of sample breaking.

- Approach to start:
  - Use model pTHF-PBT copolymers and vary:
    - MW (and blends of different MW)
    - Soft block length
  - Start with cyclic tensile/compression as function of time and temperature
  - Look to see if double dynamic concepts, e.g.vitrimer etc, could be applicable to these TPE

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