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Materials Resource Management

Material selection for temperature sensitive actuators manufactured from shape memory alloy (SMA) wires embedded in polymer structures

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Introduction:

- SMA can undergo large deformations, but can return to their undeformed shape by heating → high actuation energy

- Additive manufacturing and integration of SMA wires in polymer matrices offer several benefits compared to actuators made from bulk material:
  - High **design freedom**
  - **Vibration control** and damping
  - Application of matrix **materials with high elasticity**
  - **Conductive heating** allows a faster actuation
  - Prestrained SMA wires enable **two-way shape-memory-effect**

Problem:
- Optimum material combination ?
- Properties of the compound ?

Constraints for matrix material selection:

- Amorphous thermoplastics to limit shrinkage
- Elastic elongation higher than 2,5 % to avoid damage
- Glass transition temperature higher than 80°C to avoid creep

→ Ashby map (Fig.1) based on constraints indicates PC and PA as the most eligible matrix materials

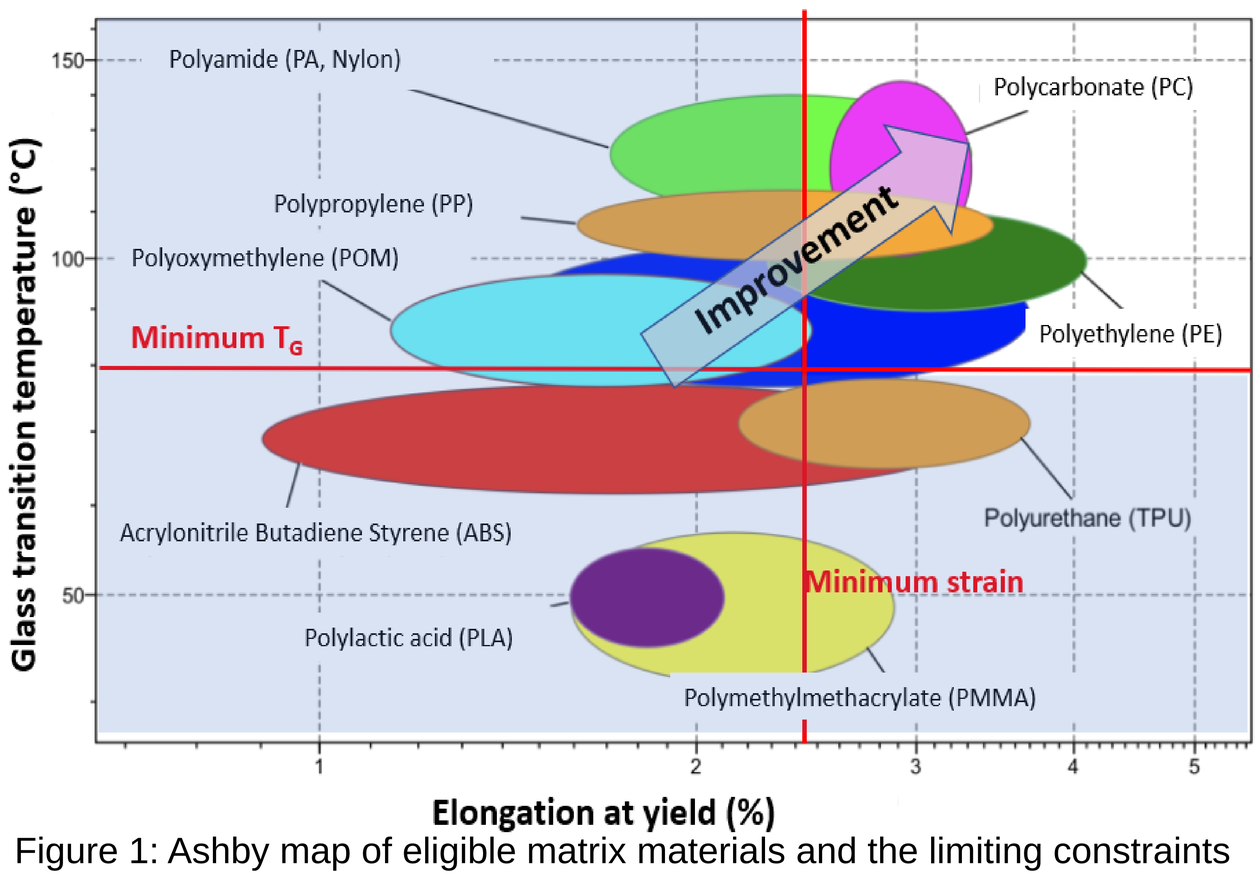

Figure 1: Ashby map of eligible matrix materials and the limiting constraints

Conducted tests:

- First experiments are conducted on ABS samples to define range of the properties

→ Tensile tests (DIN EN ISO 527) to determine the elastic elongation

→ DSC (DIN EN ISO 11357-2) to determine the glass transition temperature

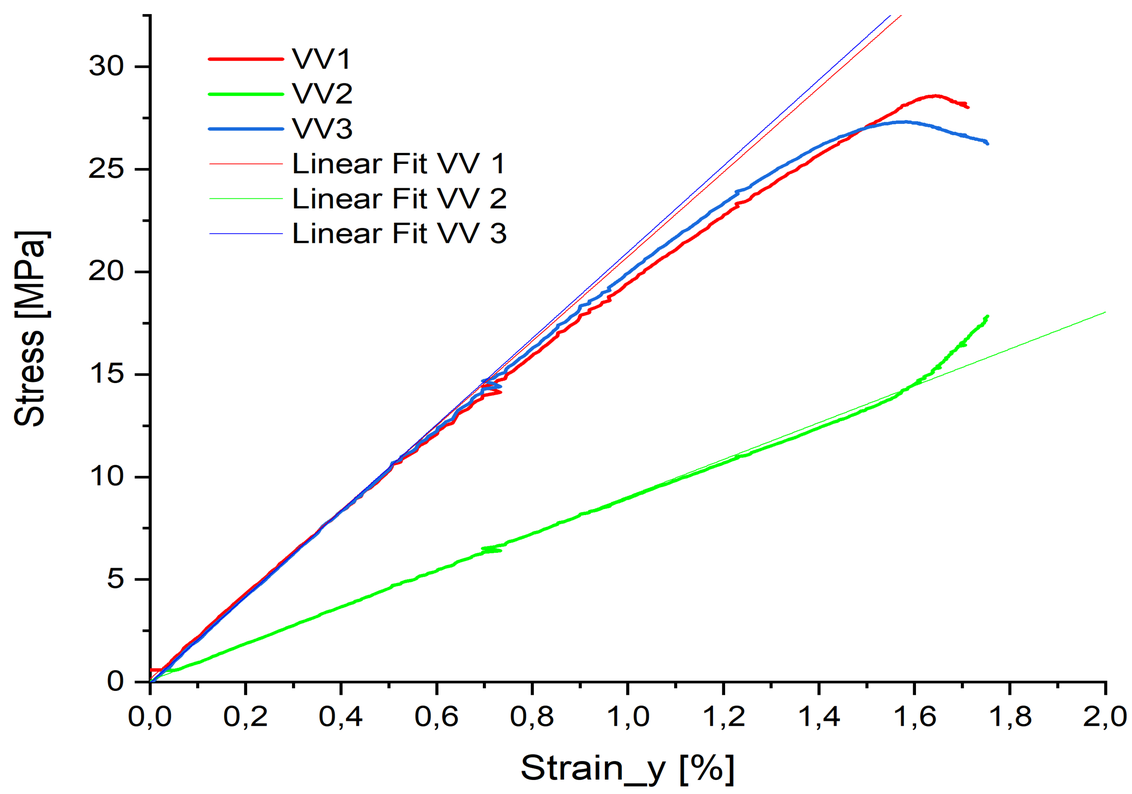

Figure 2: Stress strain diagram used for determination of the maximum elastic elongation of ABS

Results:

- Maximum elastic elongation: about 0,6 % (Fig.2)
- Glass transition temperature: about 100°C

→ ABS is not a suitable matrix material

→ Other potentially suitable materials need to be tested for final material selection

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