Ecofriendly Materials based on PHA (Polyhydroxyalkanoates) Tuned for Injcetion Moulding

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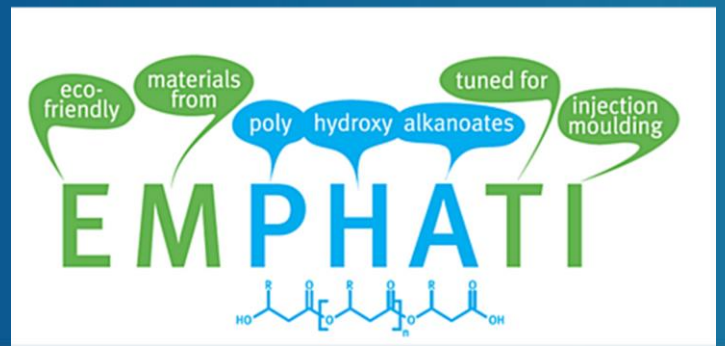
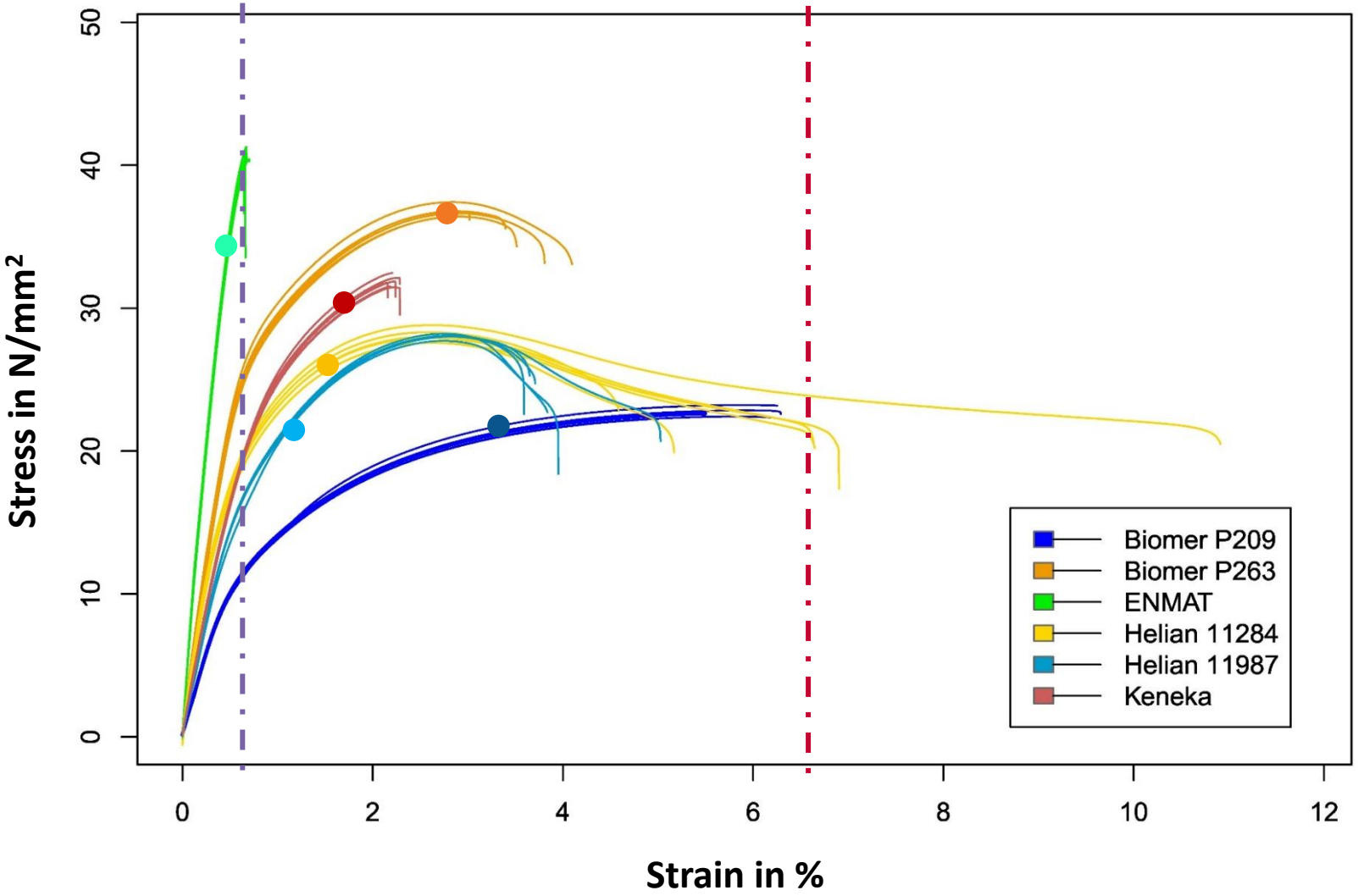


Agenda

- Research status
- UV weathering tests
- Water ageing tests

Research status

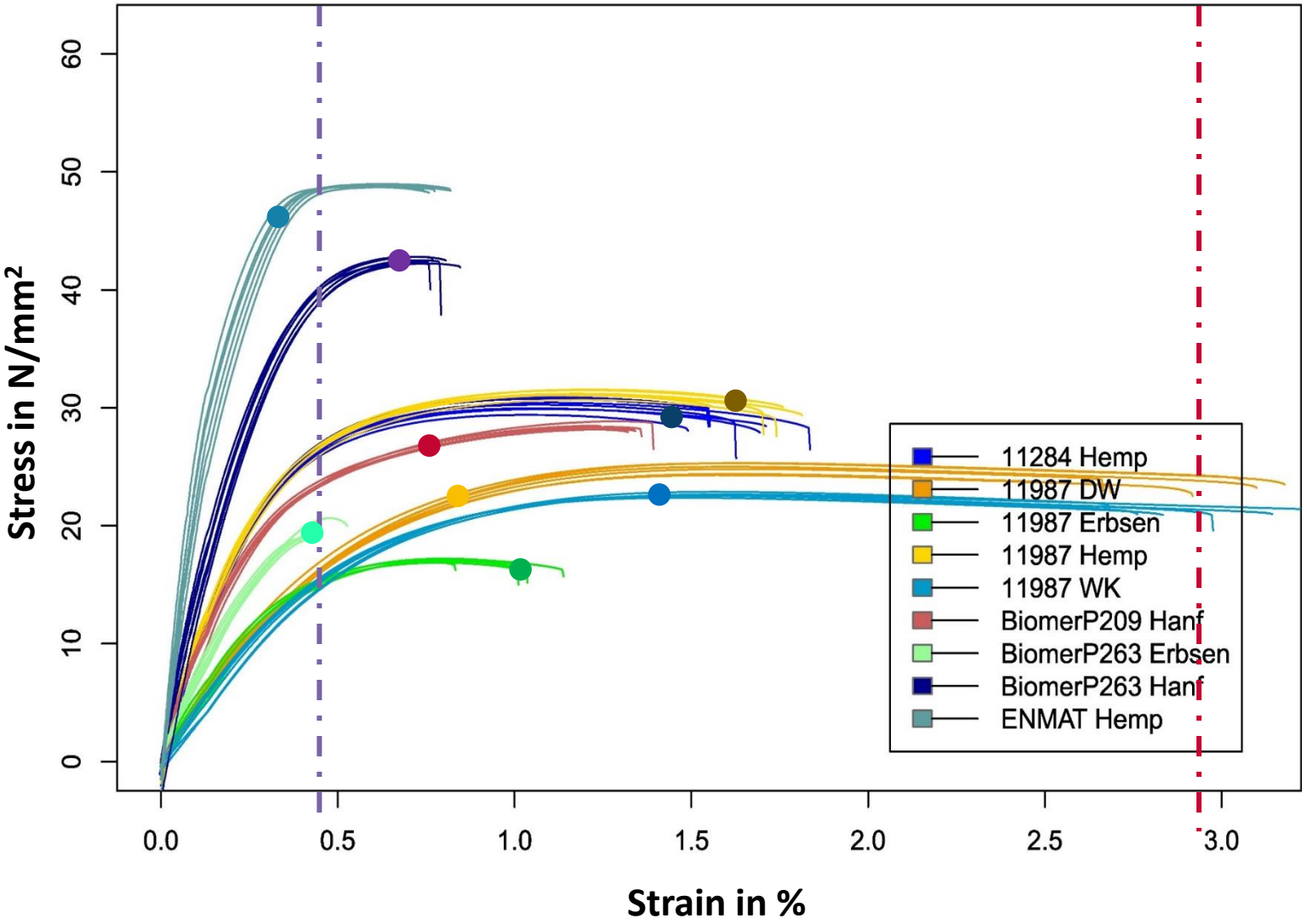
Pure PHAs



Polymer	Tensile strength in MPa	Tensile modulus in GPa
Biomer P209 P	22.63	1.12
PHAx 11284	28.03	2.25
PHAx 11987	28.00	1.55
Keneka	31.80	1.72
Biomer P263 P	36.74	2.45
ENMAT Y1000P	40.70	4.50

Research status

PHA/blends



Blends	Tensile strength in MPa	Tensile modulus in GPa
PHAx11987/Pea	17.04	2.18
Biomer P263/Pea	19.28	3.19
PHAx11987/Combed Wool	22.59	2.08
PHAx 11987/German Wool	24.85	2.32
Biomer P209/Hemp	28.40	4.02
PHAx11284/Hemp	30.13	4.91
PHAx11987/Hemp	31.12	4.89
Biomer P263/Hemp	42.48	6.74
ENMAT Y1000P/Hemp	48.8	10.99

Research status

Pure PHA

Bekuplast			TKT Consumer parts		
Tensile strength	> 20 MPa	✓	Tensile strength	> 45 MPa	✗
Elongation at yield	> 5 %	✓	Elongation at yield	> 2.6 %	✓
Charpy notched	> 6 kJ/m²	✗	Charpy notched	> 20 kJ/m²	✗
Charpy unnotched	> 50 kJ/m²	✗	Charpy unnotched	> 90 kJ/m²	✗
MFR at 190 °C	> 25 g/10 min	✓	Melt volume rate	> 19 cm³/10 min	✓
HDT	> 55 °C	✓	HDT	> 95 °C	✗

Research status

PHA/blends

Bekuplast			TKT Consumer parts		
Tensile strength	> 20 MPa	✓	Tensile strength	> 45 MPa	✓
Elongation at yield	> 5 %	✗	Elongation at yield	> 2.6 %	✗
Charpy notched	> 6 kJ/m²	✗	Charpy notched	> 22 kJ/m²	✗
Charpy unnotched	> 50 kJ/m²	✗	Charpy unnotched	> 180 kJ/m²	✗
MFR at 190 °C	> 25 g/10 min	✗	Melt volume rate	> 19 cm³/10 min	✗
HDT	> 55 °C	✓	HDT	> 95 °C	✓

Challenges

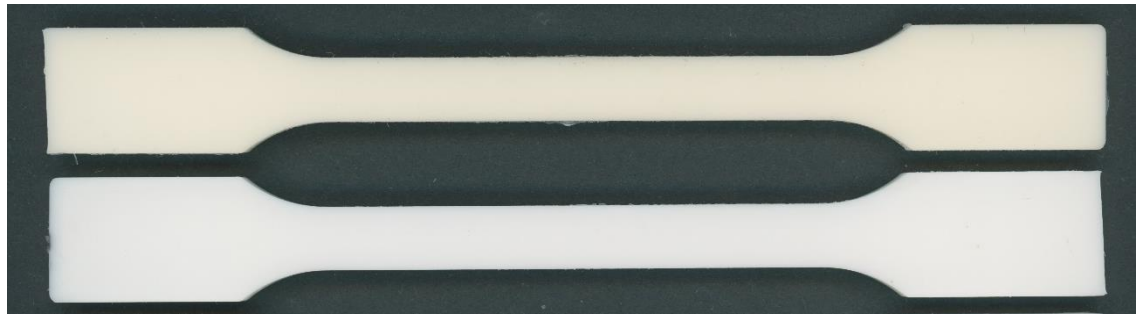
- Brittleness of the compounds
  - Additives
  - Natural elastomer
- Adhesion
  - Polydopamine

UV weathering & Water ageing tests

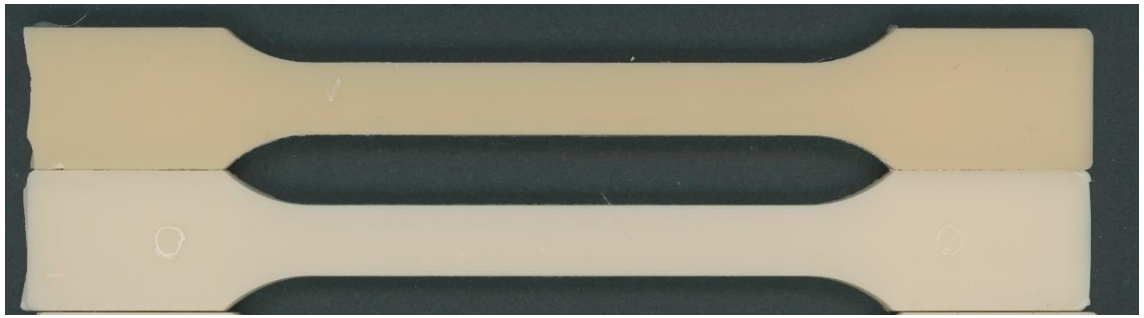
- UV weathering test – 1000 hours
  - Pure PHAs and PHA/blends
  - Change in colour measurement
  - Tensile, Impact, and HDT tests
- Water ageing in distilled water at 50 °C – 1, 2, 3, 4, 6, and 12 months
  - On PHAs and all PHA compounds developed

UV weathering tests

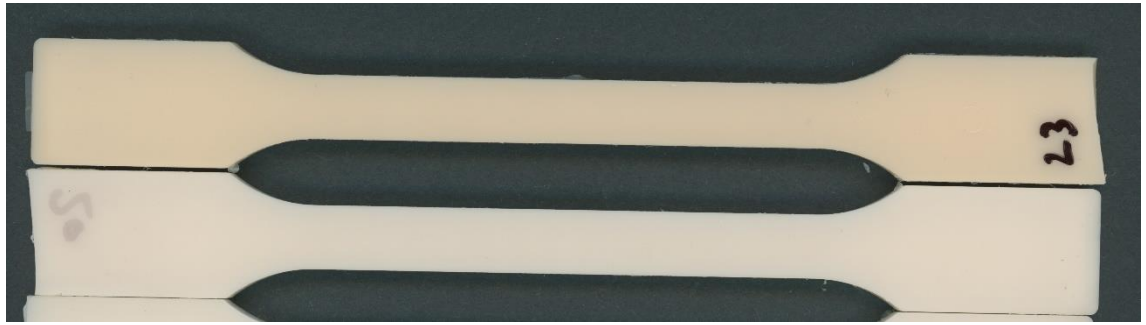
UV weathering for 200 h : Pure PHAs



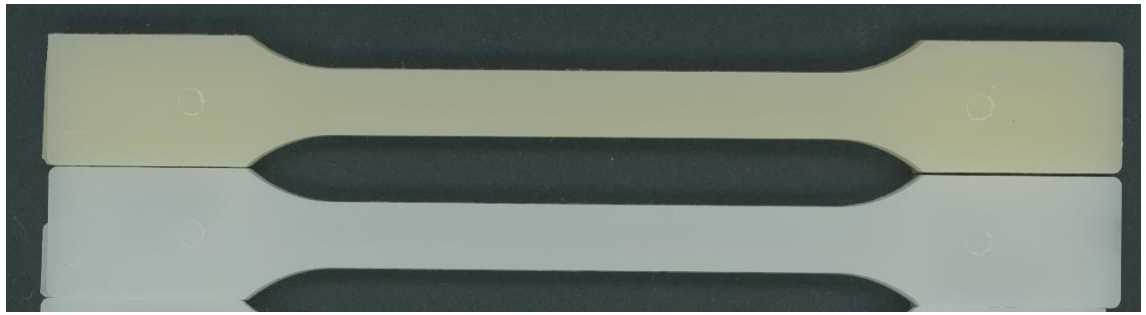
Biomer P209P



ENMAT Y1000P

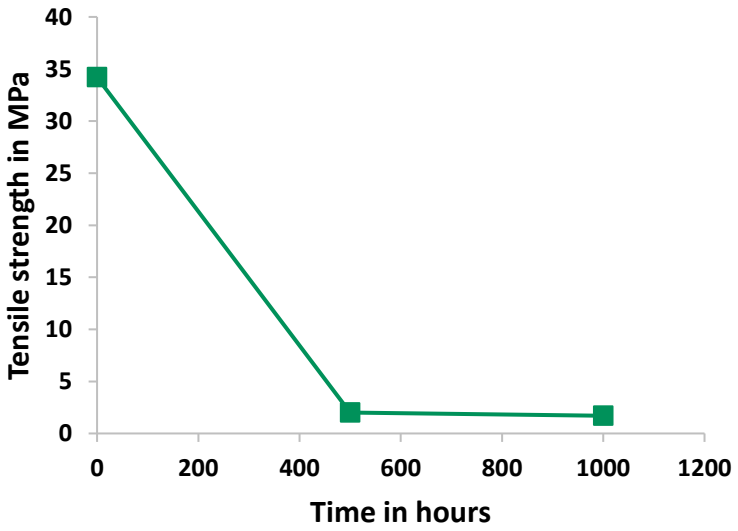


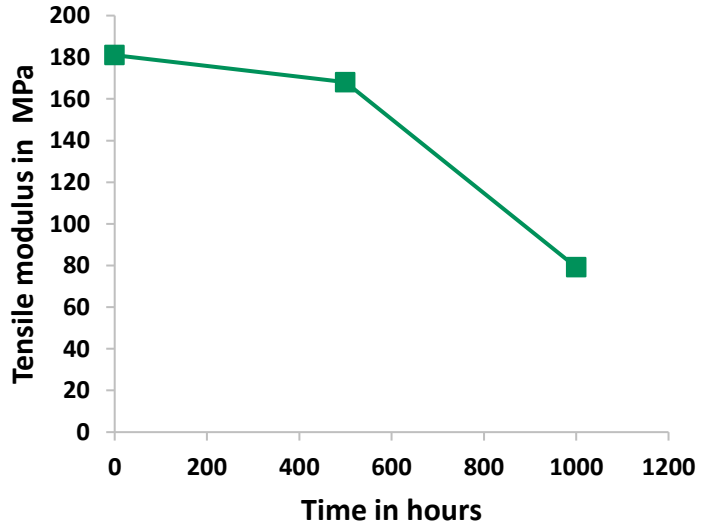
PHAx 11987

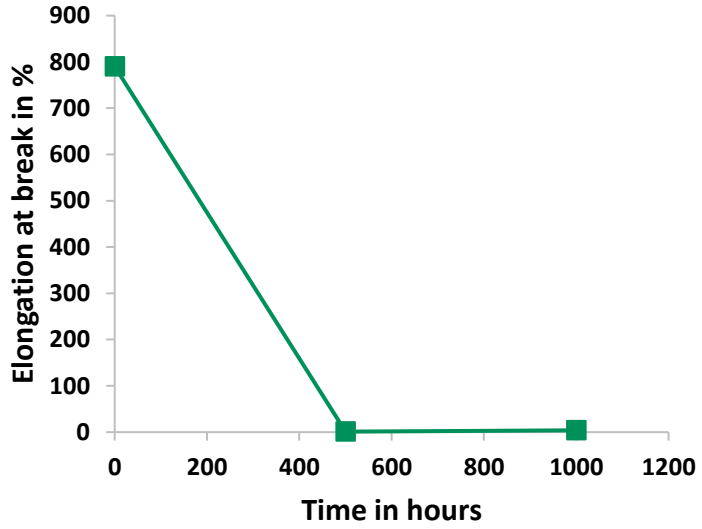


Keneka

UV weathering tests



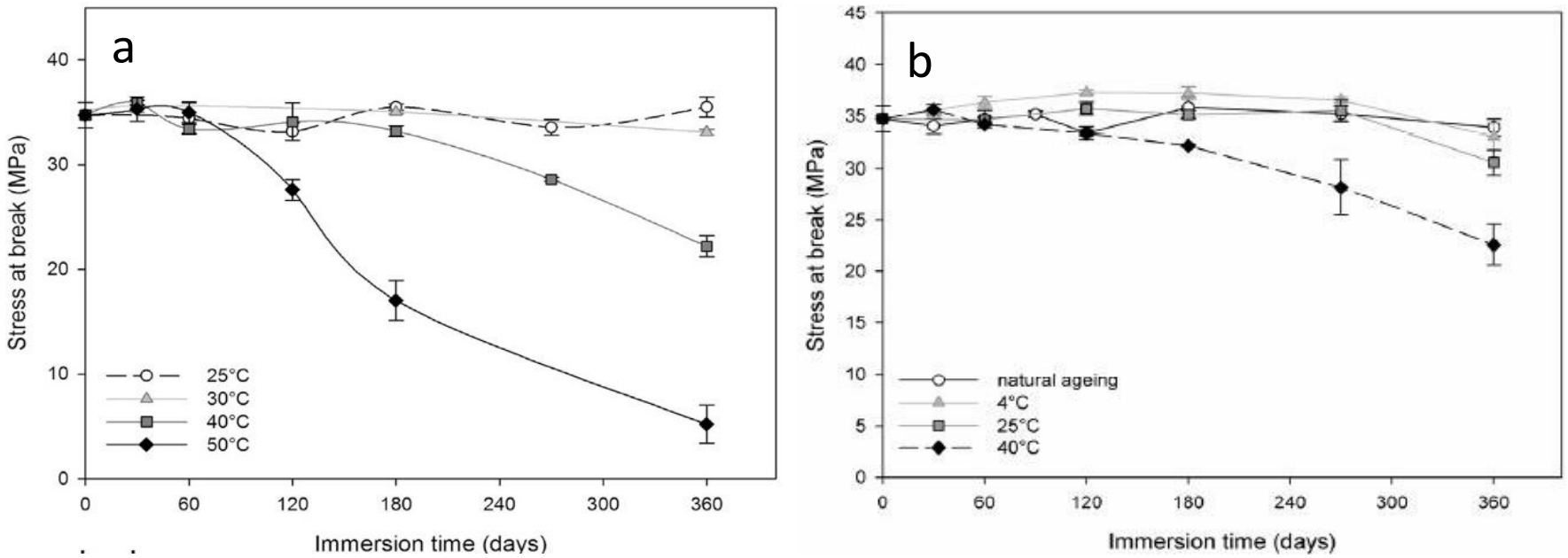




Influence of UV weathering on the mechanical performance of the PHBV (Antune et.al. 2020)

Water ageing test

Water ageing in distilled water at 50 °C



Influence of temperature and water medium (a- distilled water, b, salt water) on the mechanical properties of the PHBV (Deroiné et.al. 2014)

Next steps

- Increasing the toughness of the compounds
  - Additives
  - Natural elastomer
- Increasing the fibre-matrix adhesion

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Thank You for Your Attention

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References

- Morgan Deroiné, Antoine Le Duigou, Yves-Marie Corre, Pierre-Yves Le Gac, Peter Davies, Guy César, Stéphane Bruzaud. 2014, Seawater accelerated ageing of poly(3-hydroxybutyrate-co-3-hydroxyvalerate), Polymer Degradation and Stability, Vol. 105, p. 237-247 DOI:10.1016/j.polymdegradstab.2014.04.026.
- Antunes Ana, Anton Popelka, Omar Aljarod, Mohammad K. Hassan, Peter Kasak, and Adriaan S. Luyt. 2020, Accelerated Weathering Effects on Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) and PHBV/TiO2 Nanocomposites, Polymers 12, no. 8: 1743, DOI: 10.3390/polym12081743.