



We create chemistry

High performance LSZH thermoplastic polyurethanes (TPU) for wire and cable

Polymers in Cables 2018

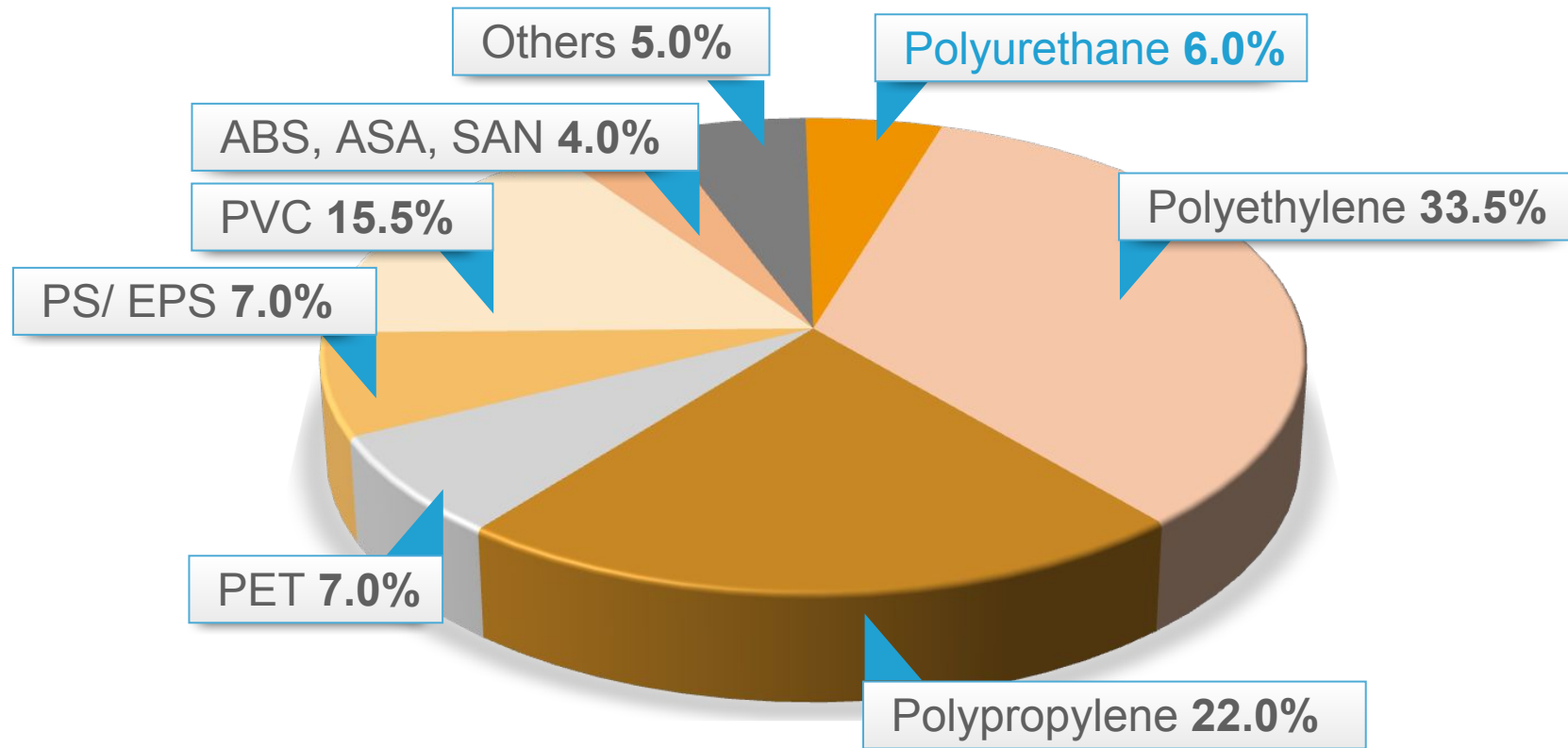
Oliver Muehren, Christopher A. Bradlee

Agenda

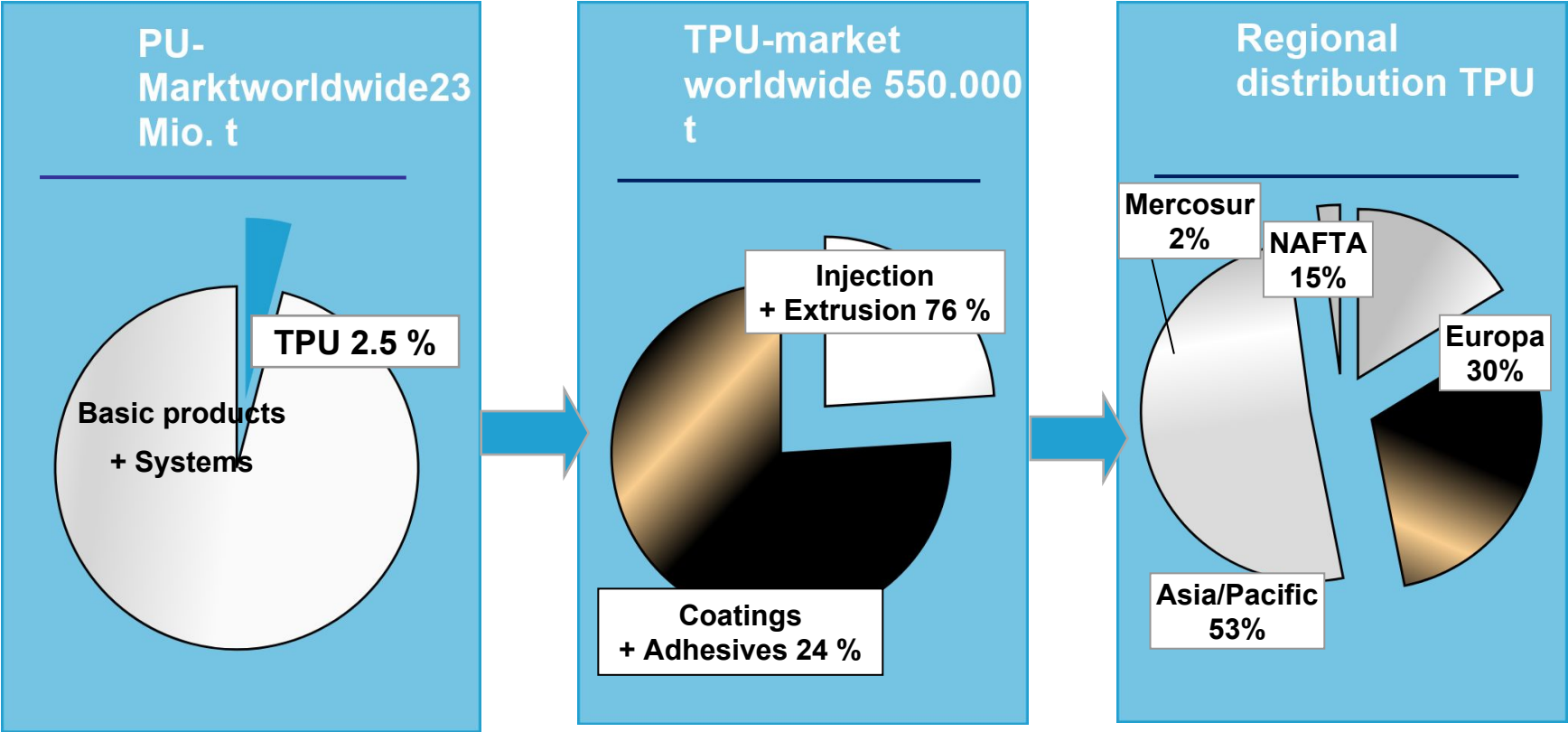
1. Overview of Plastic Polymer Market
2. Wire and Cable Applications of TPU
3. FR and Physical Performance of Elastollan TPU

Plastic Material Consumption

Worldwide 2016 – 330 million tons



TPU – World-Market 2017



Source: Bluebook and BASF estimations.

Wheel speed sensor cables



Cabling for rear view camera



Charger cables for electric vehicles



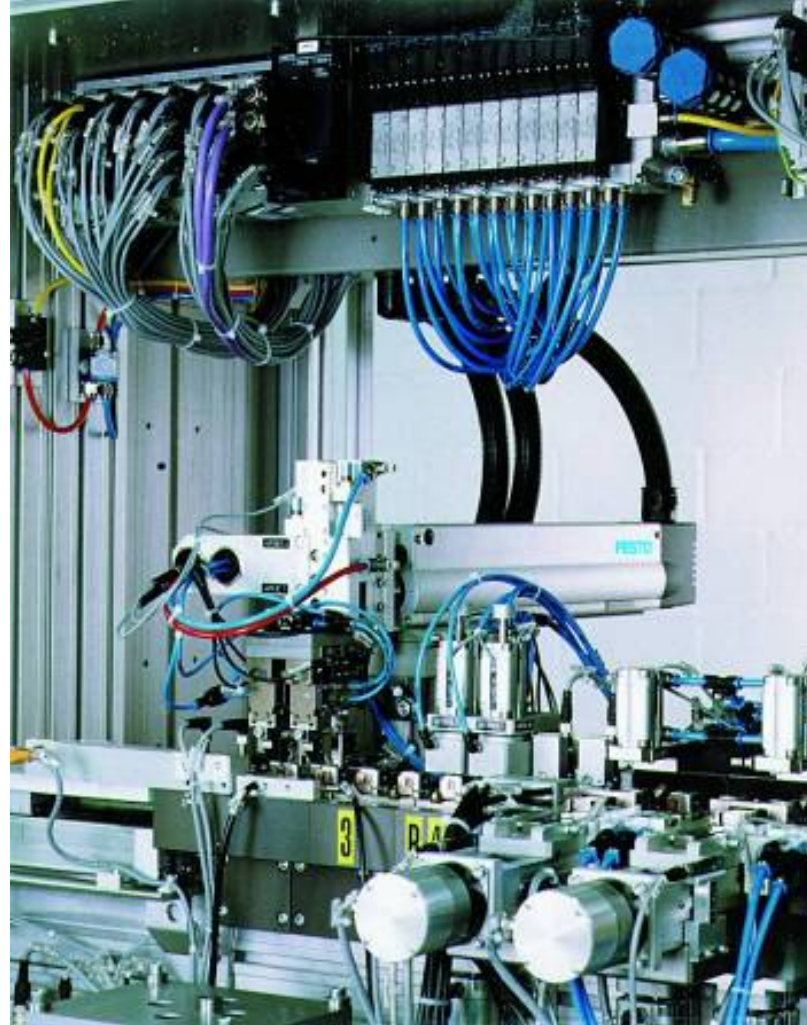
Requirements:

- ▶ flexibility, even at lowest temperatures
- ▶ resistant against mechanical stress, microbes, weathering, humidity
- ▶ wide temperature range; halogen free flame retardant
- ▶ recycable, easy to process; able for being spiralized
- ▶ *EN 50620 / EVM-1*

Charger cables for electric vehicles



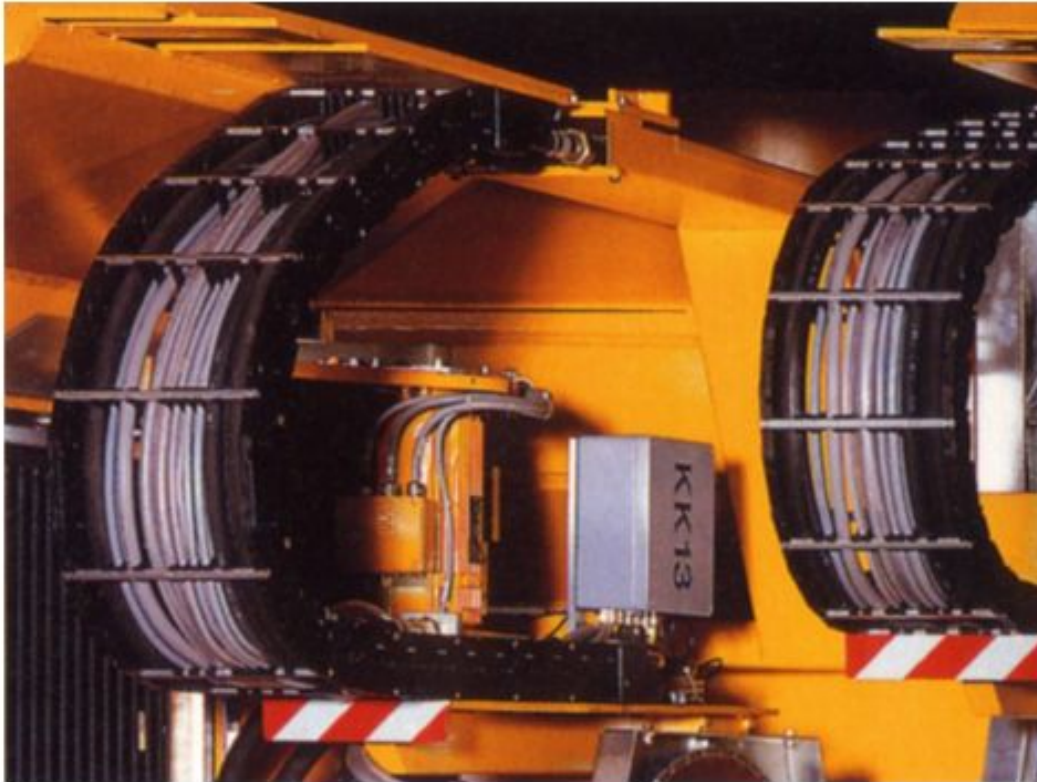
Industrial applications



Cables for robots and automatic devices need to be flexible, abrasion resistant and resistant to long term stress. Sheathed with TPU even with a halogenfree flame retardant grade they achieve a long lifetime.

Industrial applications

Drag chain and robotic cables



Injection molding of TPU or PU-systems



Cable connectors, grommets and plugs made of Elastollan for excellent flexibility, watertightness, tear and impact strength



TPU for consumer electronics

Elastollan



Key features

- Hardness: $93,3 \pm 0,5$ Sh A
- Tensile strength $20,3 \pm 1,4$ MPa
- Elongation at break: $488 \% \pm 27 \%$
- Tear strength: $63,9 \pm 3,3$ N/mm
- Abrasion loss: $74,4 \pm 6,5$ mm³
- Excellent chemical resistance
- Halogen free flame retardant, UL VW1
- Outstanding reliability

Flame Retardance in TPU is a Balancing Act

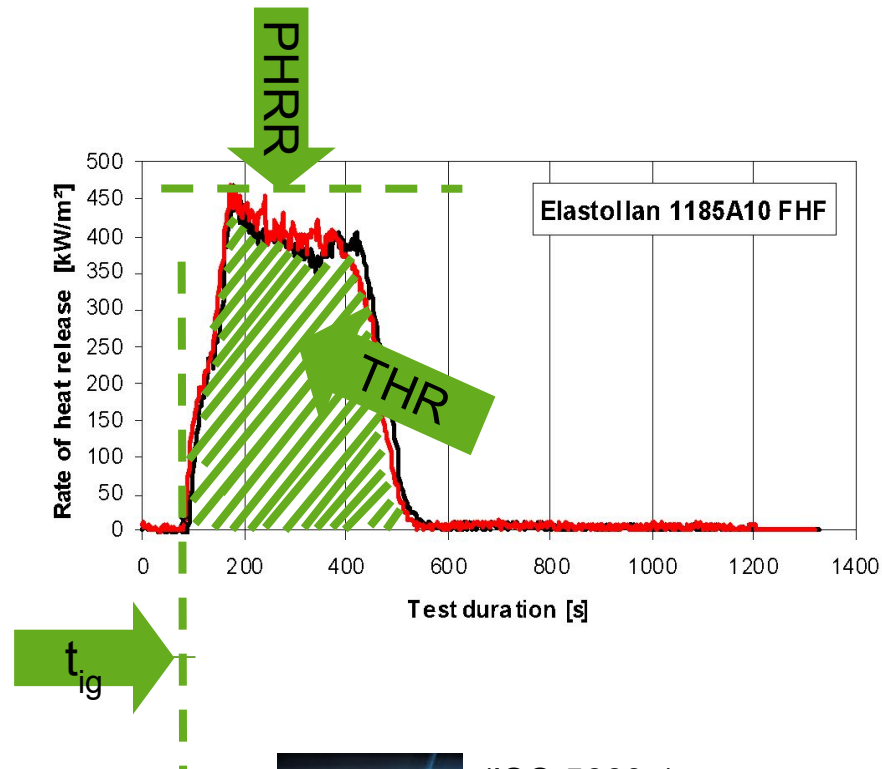
- TPU is flammable, so...have to add a mineral filler to stop the burn
- Adding mineral filler degrades the physical properties of the TPU
- The more filler.....the more degradation in properties
- The **challenge** in finding a balance between **flame resistance** while maintaining the required **physical properties**

How do you achieve superior FR protection, while still having the physical performance of a TPU

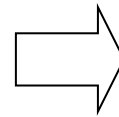


From cone data to Petrella* Plot

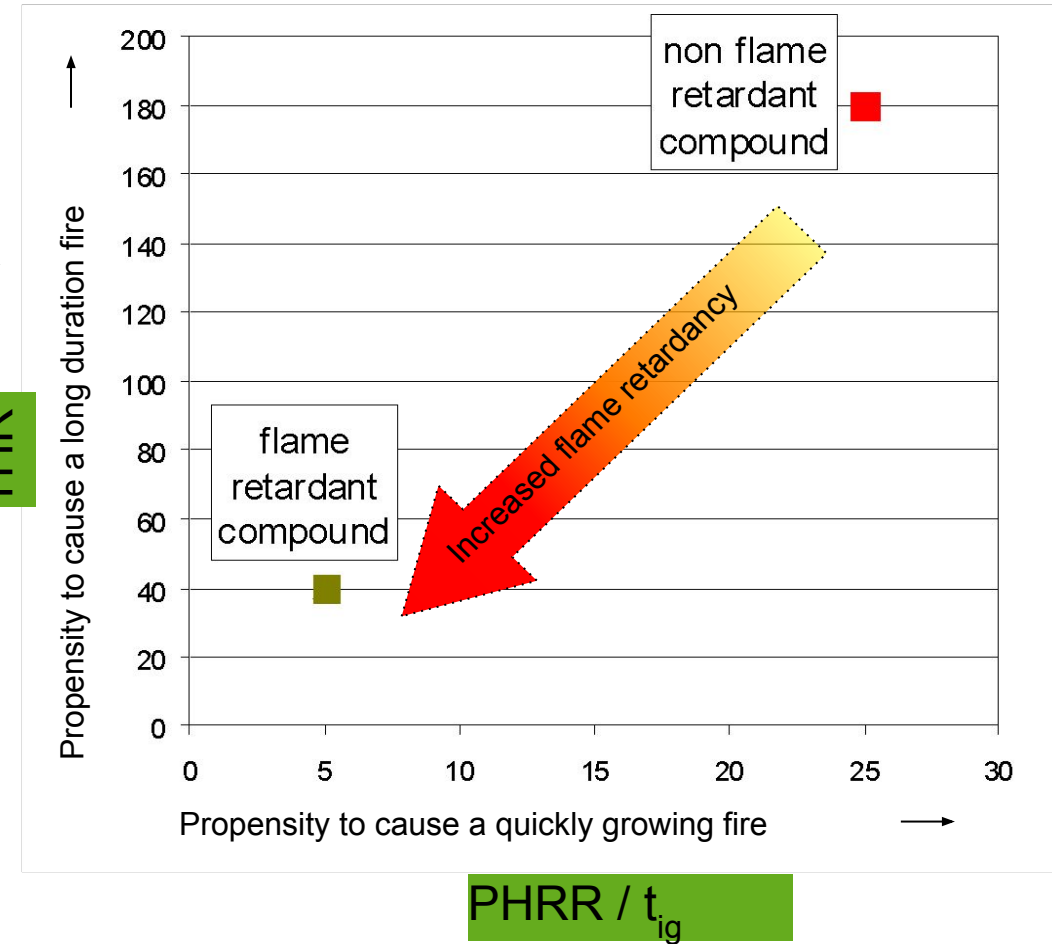
* Petrella R.V., The assessment of full scale fire hazard ; from cone calorimeter data, *J. of Fire Science*, 12 (1994), p. 14.



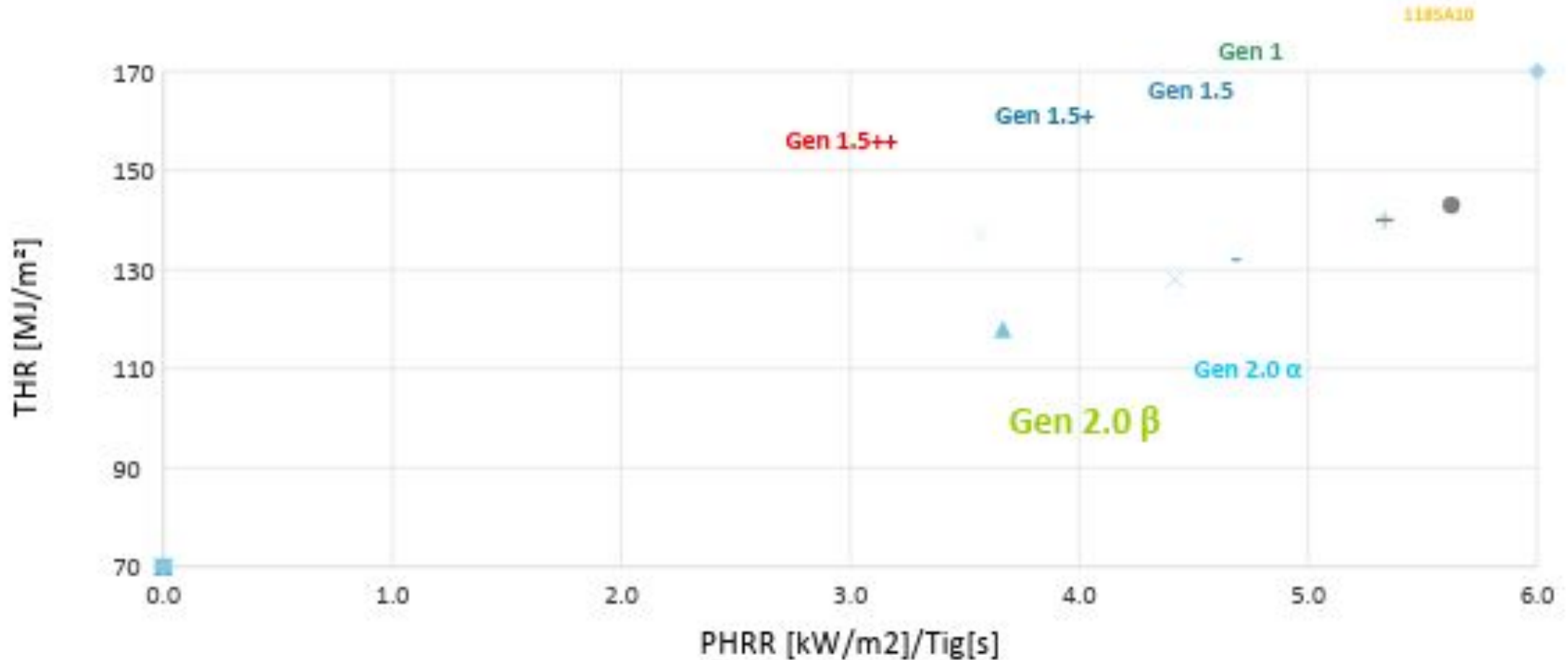
(ISO 5660-1,
100x100x5m
m samples
burned with
35kW/m²)



THR

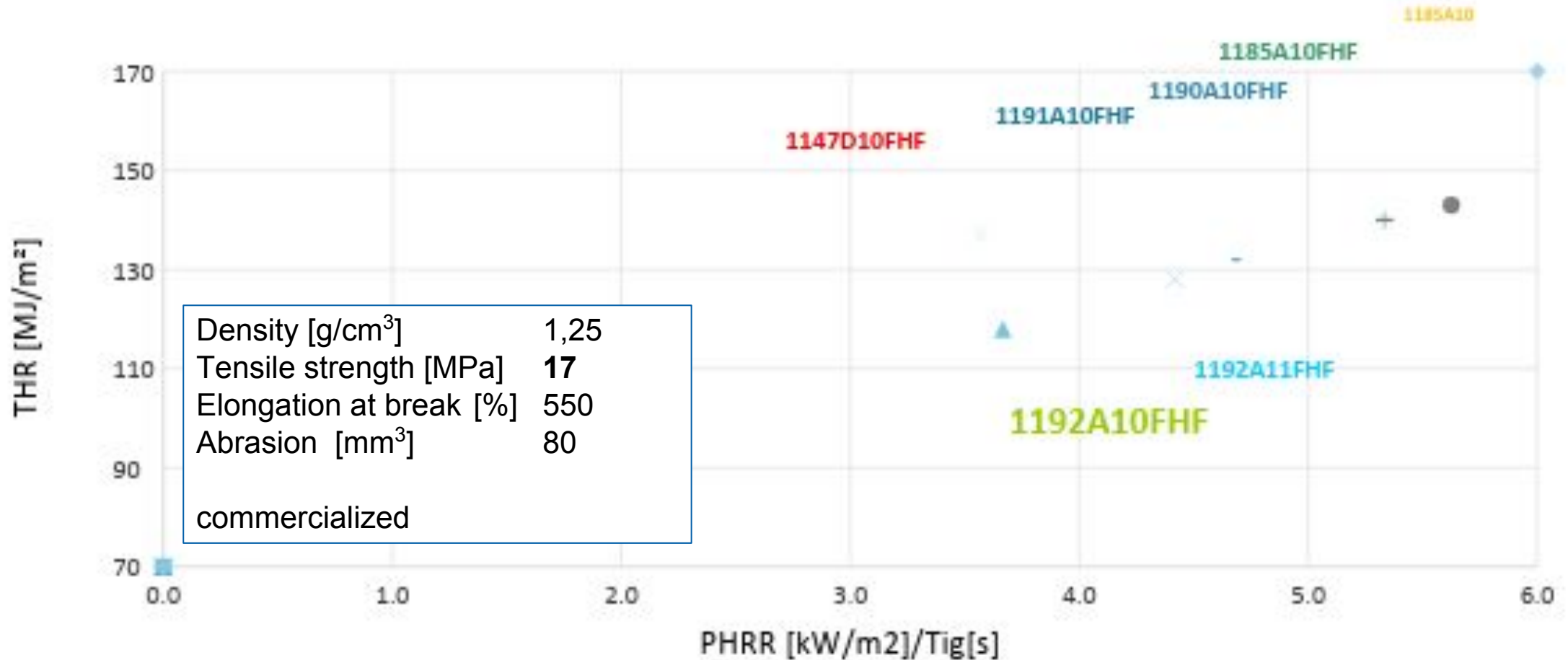


Progression of FR Elastollan TPU Development

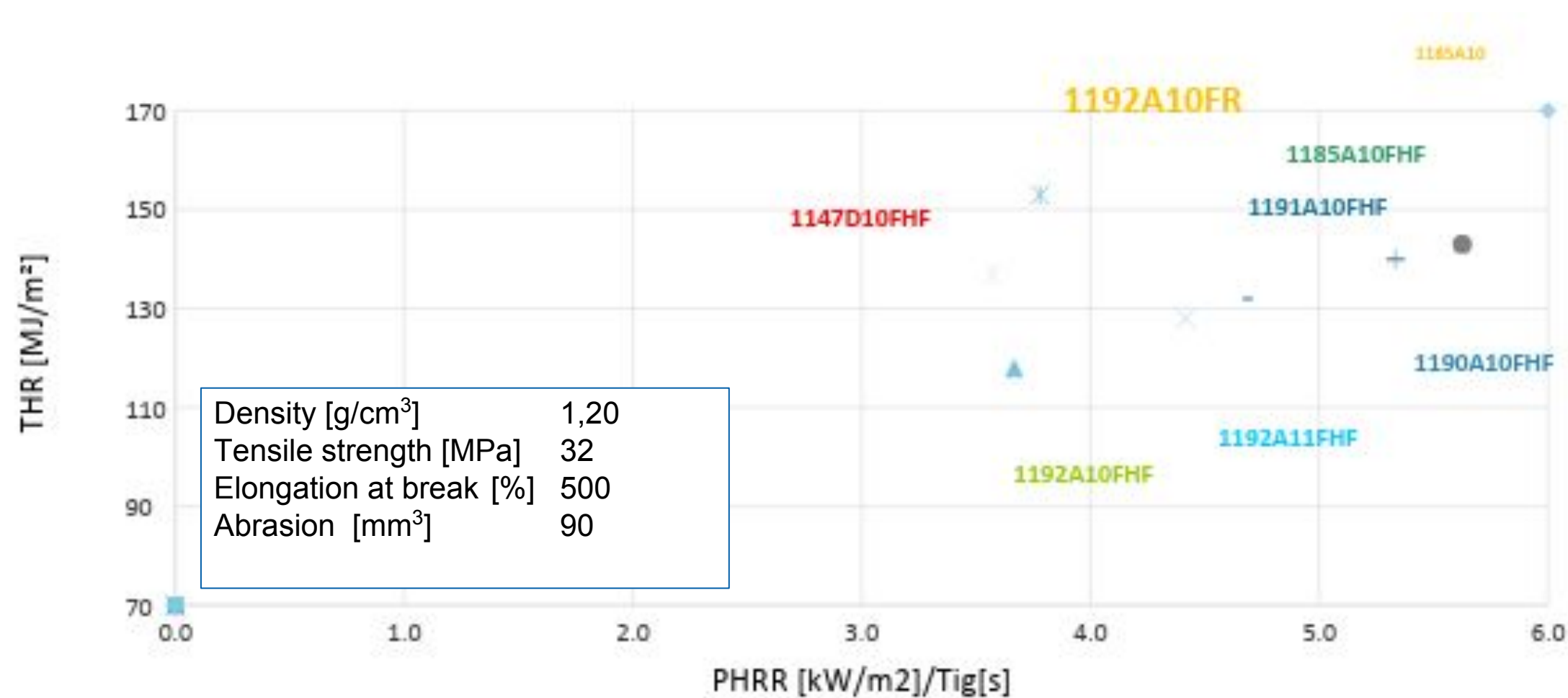


Time line: Gen 1 – 1992, Gen 1.5 – early 2000's, Gen 2.0 – 2012, Gen 3.0 - 2017

Elastollan 1192 A 10 FHF and 1192 A 11 FHF



Elastollan 1192 A 10 FR



Mechanical properties

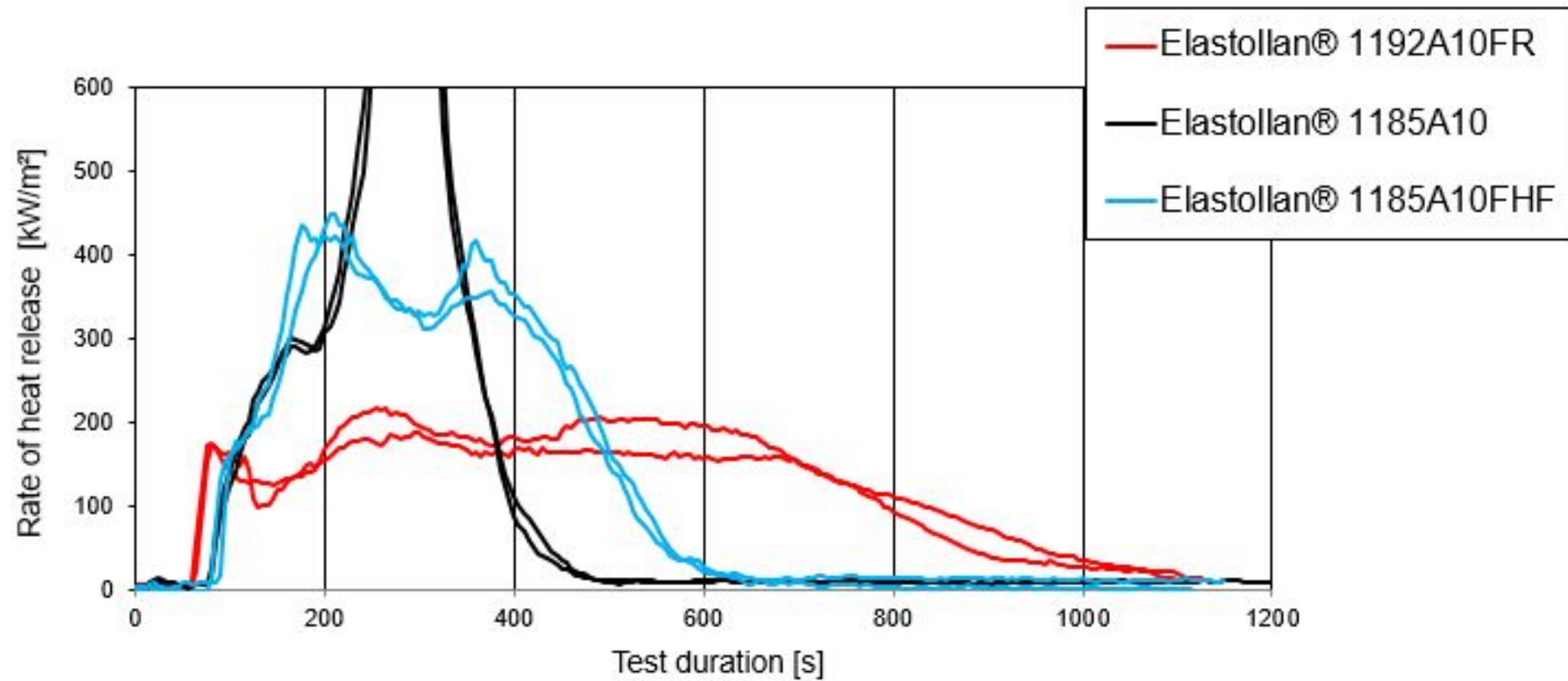
Elastollan®			1192A10FR	1185 A 10 FHF	1185A10
Tensile strength	DIN 53504-S2	[MPa]	32-36	35	50
Elongation@break	DIN 53504-S2	[%]	550	600	580
Density	DIN EN ISO 1183-1-A	[g/cm ³]	1,20	1,23	1,12
Tear strength	DIN ISO 34-1Bb	[N/mm]	65	60	70
Hardness	DIN 53505	[Shore A]	92	89	87
Abrasion	DIN ISO 4649-A	[mm ³]	90	35	25

Corrosivity - Flammability

- Acidity of gases during combustion (DIN EN 50267-2-2:1999)
- Burning behaviour by oxygen index (ISO 4589 Part 2:2006-06)

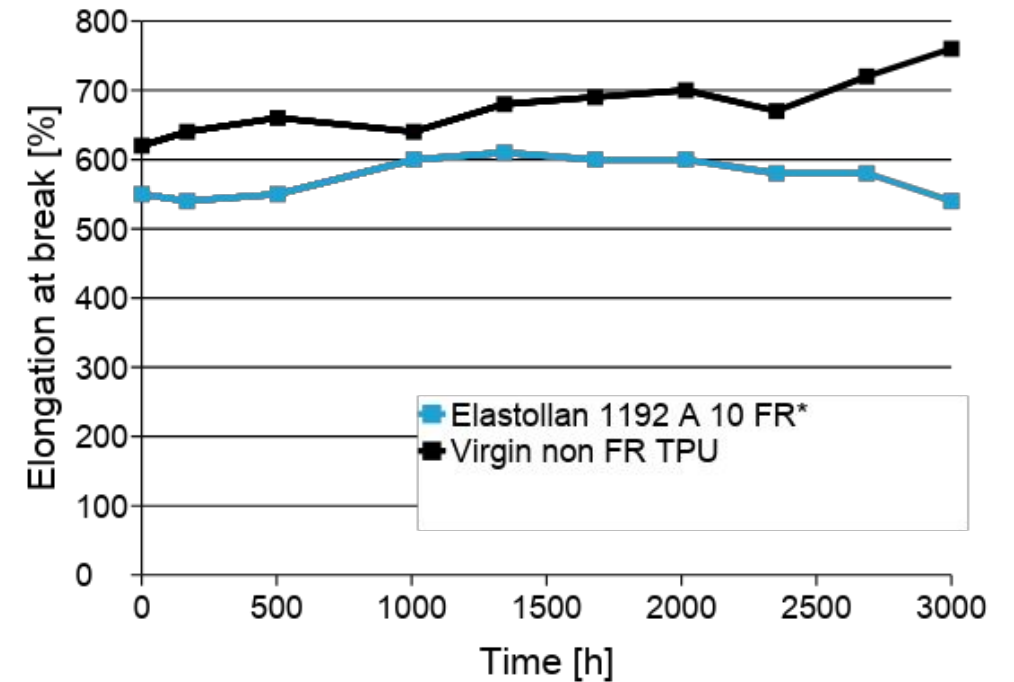
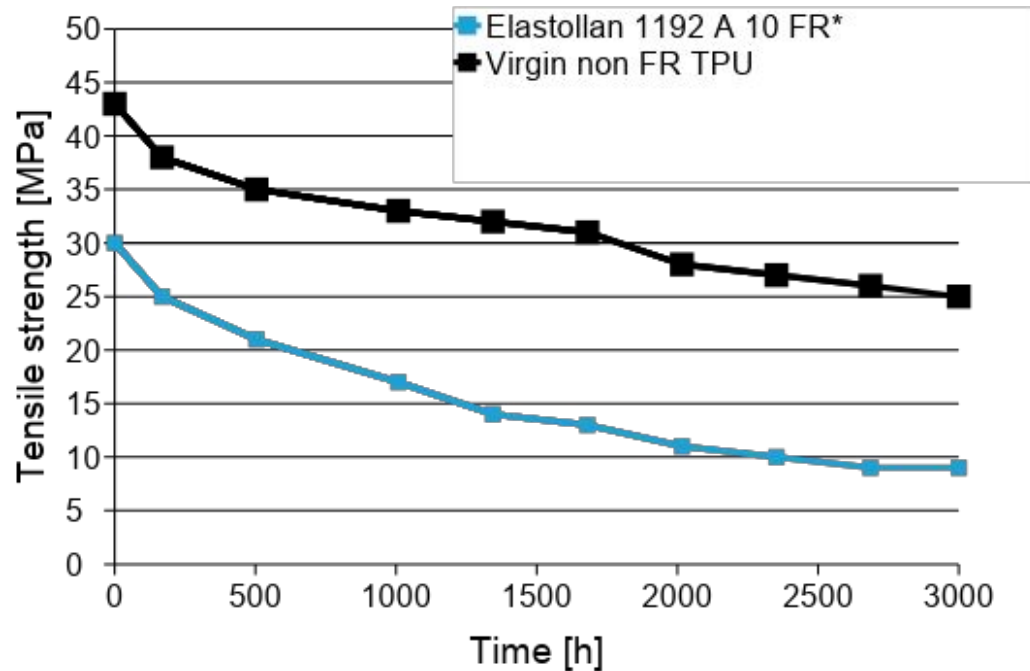
Elastollan®	1192 A 10 FR	1185 A 10 FHF	1185A10
pH-value	8,8	8,9	7,4
Conductivity [µS/mm]	23	23	4
LOI - Limiting Oxygen Index [%]	29	24	22

Heat release over time



Hydrolysis

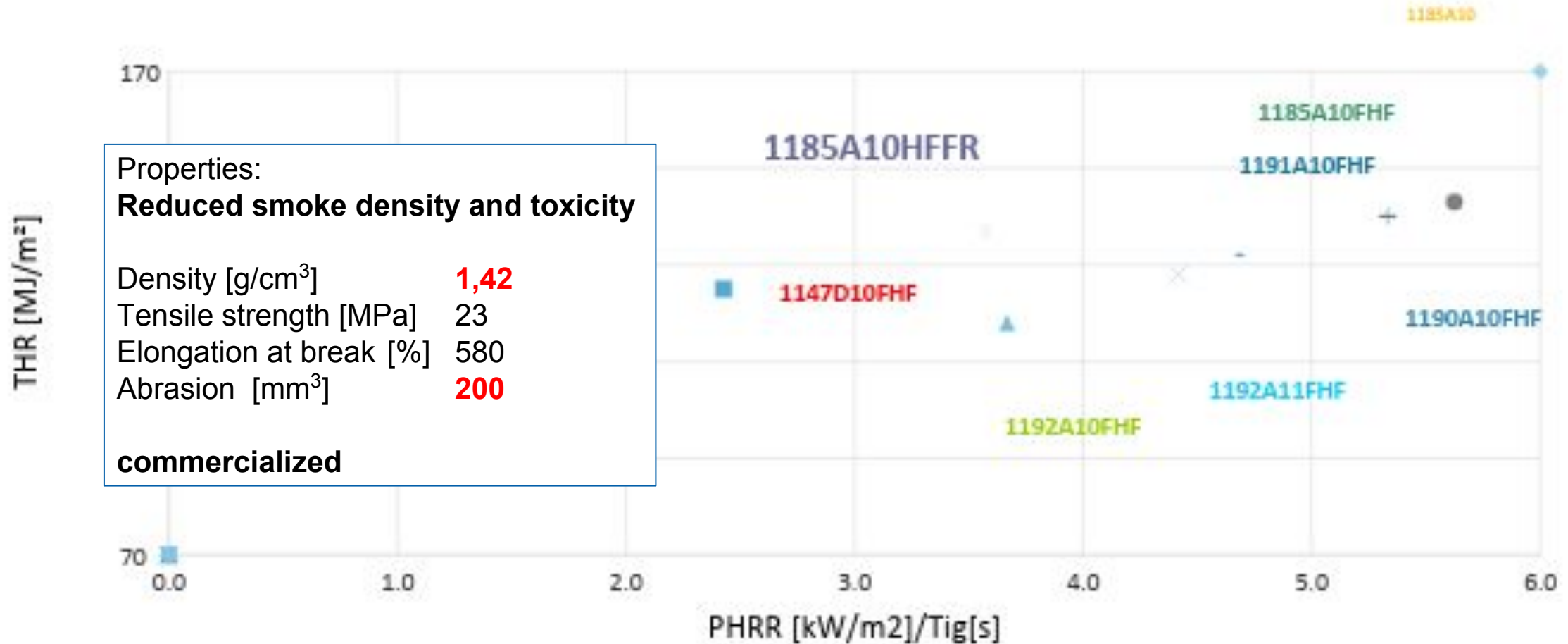
at 85 °C / 85 % relative humidity



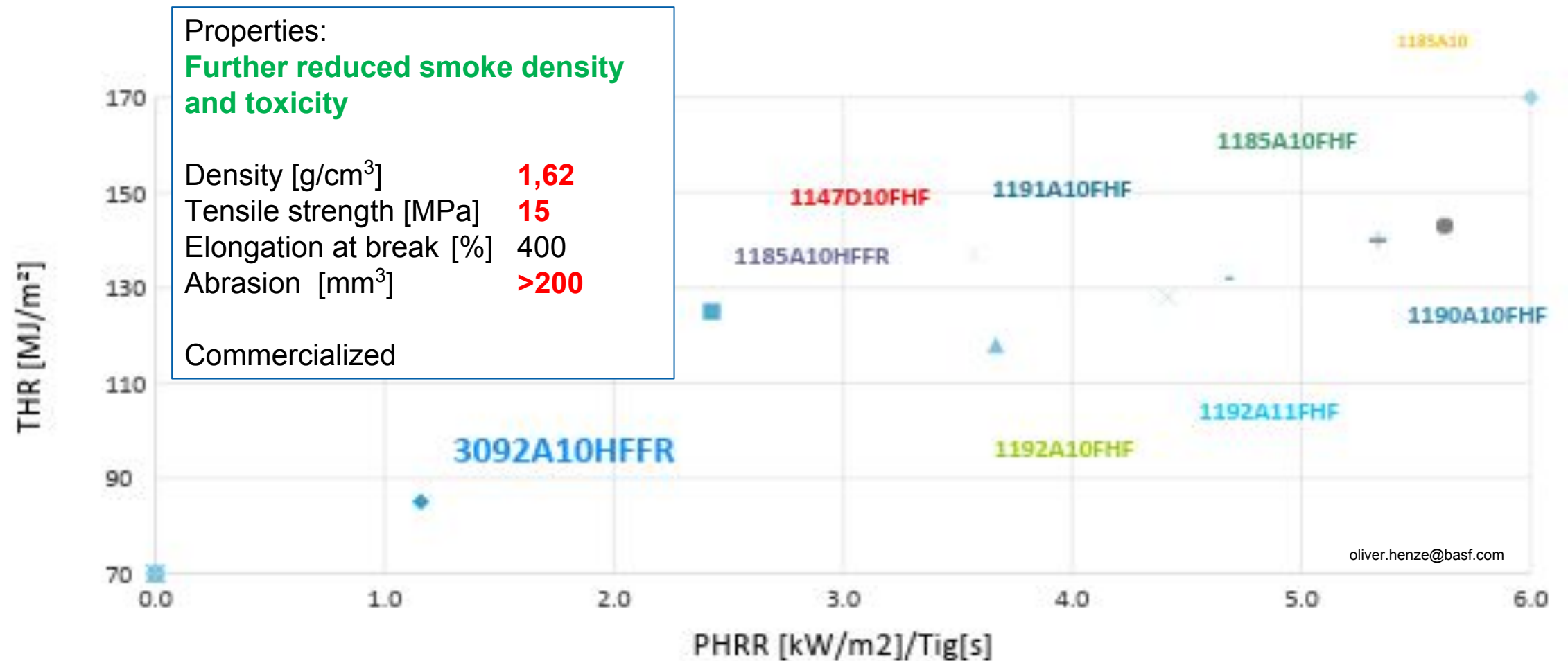
*measured on 1.6mm films

Elastollan 1192A10FR has a excellent hydrolytic stability.

Elastollan 1185A HFFR



Elastollan SP 3092A 10HFFR



Mechanical properties

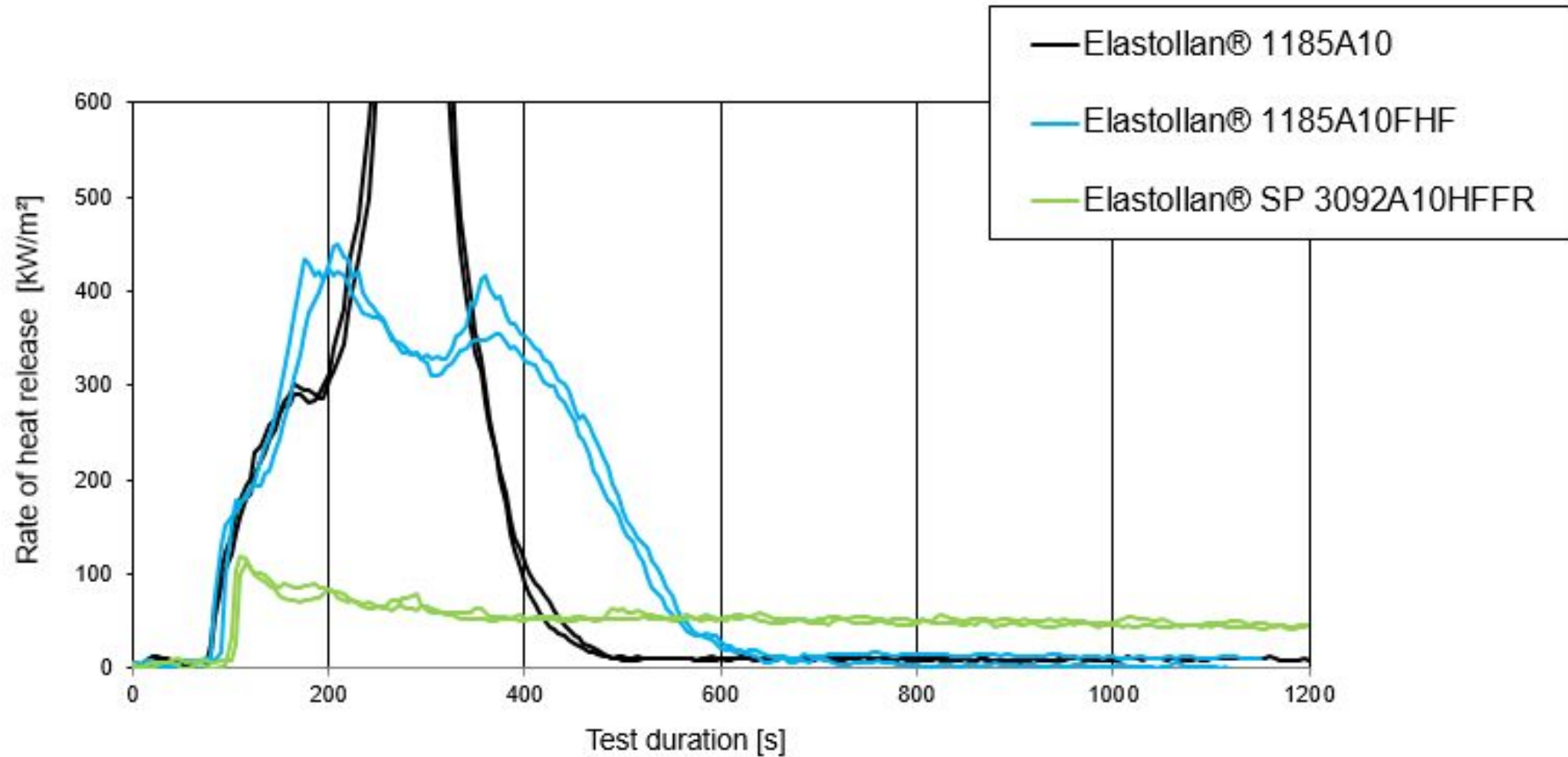
		Elastollan®	SP 3092A10 HFFR	1185A10 FHF	1185A10
Tensile strength	DIN 53504-S2	[MPa]	15	35	50
Elongation@break	DIN 53504-S2	[%]	400	600	580
Density	DIN EN ISO 1183-1-A	[g/cm³]	1,62	1,23	1,12
Tear strength	DIN ISO 34-1Bb	[N/mm]	42	60	70
Hardness	DIN 53505	[Shore A]	95	89	87
Abrasion	DIN ISO 4649-A	[mm³]	>200	35	25

Corrosivity - Flammability

- Acidity of gases during combustion (DIN EN 50267-2-2: 1999)
- Determination of burning behaviour by oxygen index (acc. to ISO 4589 Part2: 2006-06)

Elastollan®	SP3092A10 HFFR	1185A10 FHF	1185A10
pH-value	6,7	8,9	7,4
Conductivity [µS/mm]	8,3	23,4	4
LOI - Limiting Oxygen Index [%]	41	24	22

Heat release over time



DIN EN 45545-2 (2013-08) R22/R23

Railway applications - Fire protection on railway vehicles

	®Elastollan
EN ISO 5659-2: 25 kW/m ⁻² (Smoke density)	D_s max.
NF X70-100-1 und -2 (Toxicity), 600°C	CIT_{NLP}
EN ISO 4589-2: OI	Oxygen Vol%
Rating R22/23 (e.g. tubes)	

SP 3092 A10 HFFR

65
(1,6 mm)

0,10

41

HL3

A 10 FHF 1185

563
(mm 1,6)

0,36

24

no rating

DIN EN 45545-2 (2013-08) R15/R16

Railway applications - Fire protection on railway vehicles

®Elastollan

ITC

(DIN EN 50305 (800°C

Smoke Density – Cube test (IEC 61034)
(on the example power cord cable

[%] Transmission

Rating R15/16
(e.g. cables)

SP 3092 A 10 HFFR

8,4

62

HL1/HL2

A 10 FHF 1185

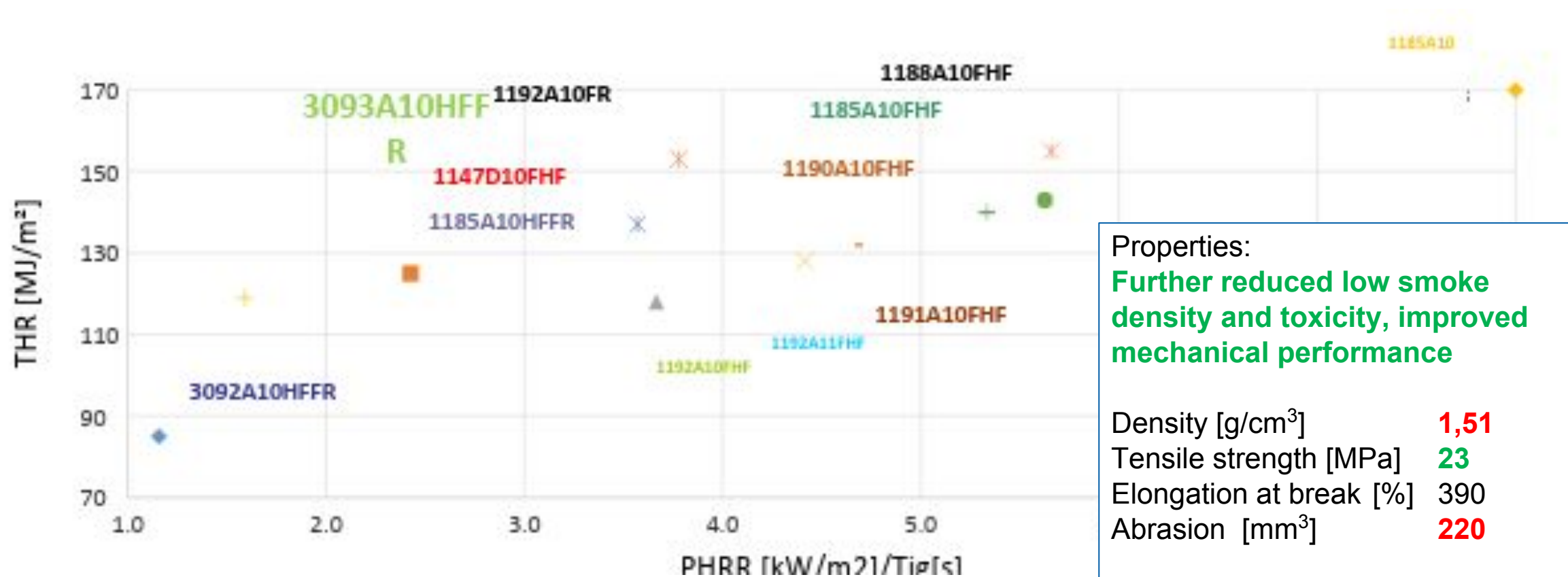
46

27

no rating

Elastollan 3093A10HFFR

Petrella plot standard materials enlarged



Elastollan SP 3093 10 HFFR

Railway applications DIN EN 45545-2 (2013-08), R15/R16 for cable applications

(1) Rating DIN EN 45545

(DIN EN 50305 (800°C

ITC

**Elastollan SP
A 10 HFFR 3093**

9,2

**Elastollan
1185 A 10
HFFR**

12,8

**Elastollan
1185 A 10
FHF**

46

Rating R15/16
(e.g. cables)

HL1/HL2

No rating

No rating

Conclusions

- Flame Retardant cables can be difficult to design and certify.
- It's a significant challenge to design LSZH TPU polymers for wire and cables.
- TPU is often selected for applications that require high physical performance and in safety critical applications, so reducing performance properties is not valued.
- The challenge is in finding a balance between flame resistance while maintaining the required physical properties



Elastollan® TPU

For More Information:



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For more informations about Elastollan® TPU:

<http://www.elastollan.basf.us>



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