MME: PP-GF for structural applications
Challenges and solutions

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MME: PP-GF for structural applications, Challenges and solutions

Agenda

- **Challenges for structures / structural applications**
- **LyondellBasell scouting initiatives (overview)**
- **Evaluation of different options with PP Compounds**
  - (Foaming)
  - Polymers
  - Fibers
- **Long term mechanical material performance**
  - Impact of exposure to coolant or heat
  - Lifetime expectation due to permanent load
    - Conventional PP resins vs. Advanced Copo resins – SGF / LGF
- **Conclusion**

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Challenges for structures / structural applications

- **Fuel / emission reduction**
  - weight of all cars have to be reduced
    - Plastics will replace metal, e.g. HT engineering plastics for powertrains or PPC for structures (liftgate)
    - Plastic parts with lower density shall be implemented
  - (Implementation of Hybrid powertrain solutions)
  - Full electric vehicles
    - New electric components (High voltage environment)
    - Lower noise level
- **Recycling**
- **Reliability/ robustness to increase sustainability**
- **…..**

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PPC themes and initiatives

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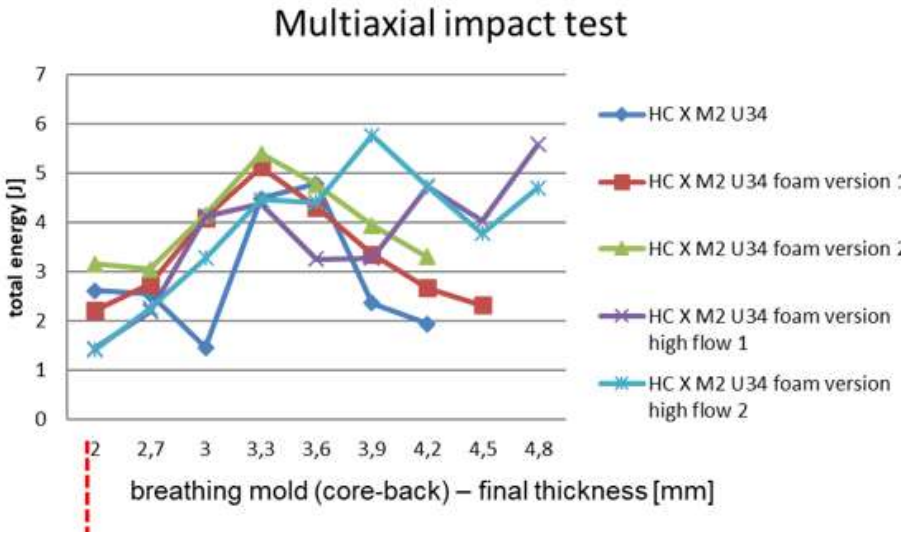
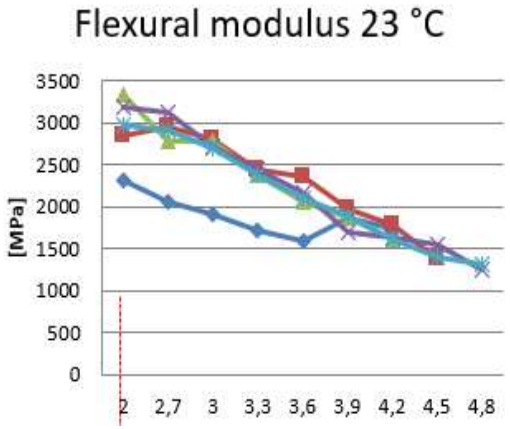
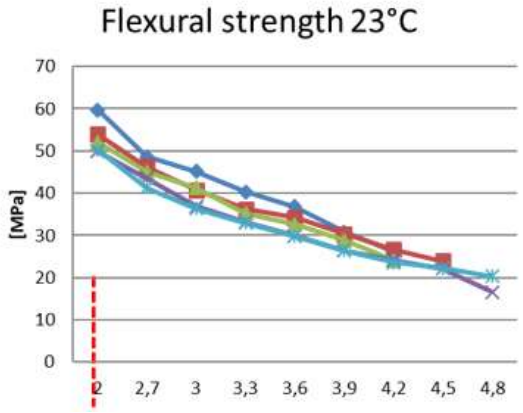
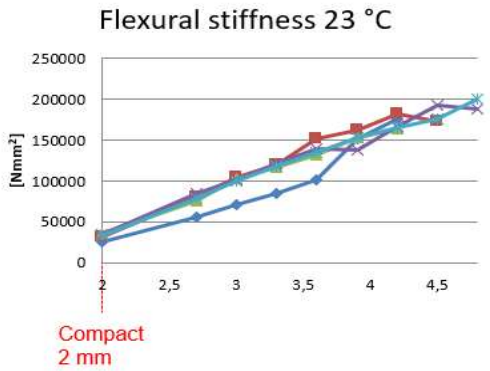
Foaming (PAD activity of Dieter Langenfelder)

Test of modified TD 20 samples









Impact of foaming to mechanical properties:

- Impact performance: first positive (thickness) then negative (delamination)
- Negative effect to modulus and strength
- Positive to flexural stiffness

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Comprehensive set of solutions for structural applications

SAVE 10

LYB weight saving initiative

Global - Intelligent - Solutions

LyondellBasell PP approach with
- ***Catalloy*** (low shrinkage),
- Low emission ***Moplen***
- Advanced Copolymer (low creep)

resins

PPC SGF

PPC CF

PPC LGF

PPC for structural parts

LyondellBasell PP approach with
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resins

LyondellBasell PP approach with
- ***Catalloy*** (low shrinkage),
- Low emission ***Moplen***
- [Advanced Copolymer (low creep)]

resins

In series

Under industrialization

In progress

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Material evaluation – Polymers (PAD activity of Sven Nietzel)

			Reference: 30% SGF		
		Base resin	HOMO-PP (LE)	Advanced Copo	*Catalloy*
Property	Method	Unit	HRG 328T BLACK	EKG 2058T BLACK	DKG 2067T BLACK
Tensile modulus, 23°C	ISO 527-2/1A	MPa	6800	6700	5000
Tensile strength, 23°C	ISO 527-2/1A	MPA	95	95	52
acU, 23°C acN, 23°C/-30°C	ISO 179/1eU ISO 179/1eA	kJ/m^2	45 9,5/7	55 11/9	60 16/9
Flowability	Indication		++	+	+
Emissions			+(+)	+(+)	o
Shrinkage (transv./long.)			3/1	3/1	2/1

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Evaluation result of different fibers (PAD activity of Mikhail Dureev)

LGF property profile vs.
SGF property profile:
++ impact (low temp.)
++ shrinkage/ warpage
+ strength
+ HDT
o density
o- stiffness

PP - LGF is the preferred solution for
IP carriers (warpage, impact)
and seem to be the prefered solution for
Liftgates (strength, impact, warpage)

New additional specification requirements
- Low emission
- Surface performance

are challenging the LGF suppliers for
new solutions i.e. new LGF compounds

PP - LGF property profile can only be
copied partially by new SGF developments
due to substantial influence of the
fiber length to the PPC property profile

Lyondellbasell offering: PP - LGF Compounds
based on specific (proprietary) LYB resins
- ***Catalloy***
- Advanced Copo
- „***Moplen*** LE“

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Material evaluation – Fibers (PAD activity of Mikhail Dureev)

			Reference target: Modul ~ 30% SGF			
			15% CF	**AC-SGF30**	**AC-LGF30**	**HF-LGF30**
Property	Method	Unit	„EKU 2211T BLACK“	EKG 2058T BLACK	EKM 2216T-30 BLACK	HYM 2226T-30 BLACK
Tensile modulus, 23°C	ISO 527-2/1A	MPa	~ 6700			
Tensile strength, 23°C	ISO 527-2/1A	MPA	75	95	120	125
acU, 23°C acN, 23°C/-30°C	ISO 179/1eU ISO 179/1eA	kJ/m^2	-- 7/4	55 11/9	60 22/20	60 18/20
Flowability	indication		+	+o	o	+(+)
Emissions			-	+(+)	+	++
Others			Very low density	Low creep Longer time to failure	Low creep Higher **L**(ifetime) **R**(elevant)**L**oad	Good surface

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Material evaluation – solutions for dedicated applications

			Hostacom GF grades		
			High impact, Low warpage, Low emission IP carrier (20% LGF dryblend)	**High stiffness, Low emission, Good surface Liftgates (30% LGF)**	**High stiffness, Long lifetime, Coolant contact AC-SGF30**
Property	Method	Unit	DRM 2234T BLACK	HYM 2226T-30 BLACK	EKG 2087T BLACK
Tensile modulus, 23°C	ISO 527-2/1A	MPa	5000	6700	6700
Tensile strength, 23°C	ISO 527-2/1A	MPA	100	125	95
acU, 23°C acN, 23°C/-30°C	ISO 179/1eU ISO 179/1eA	kJ/m^2	-- 15/17	60 18/20	55 11/9
Flowability	indication		+(+)	++	+
Remark			**Dryblend: LGF-60 based on *Catalloy* with HF *Moplen***	**Dryblend or ready to use**	**Grades with SGF content between 0 and 50% and different flowabilities**

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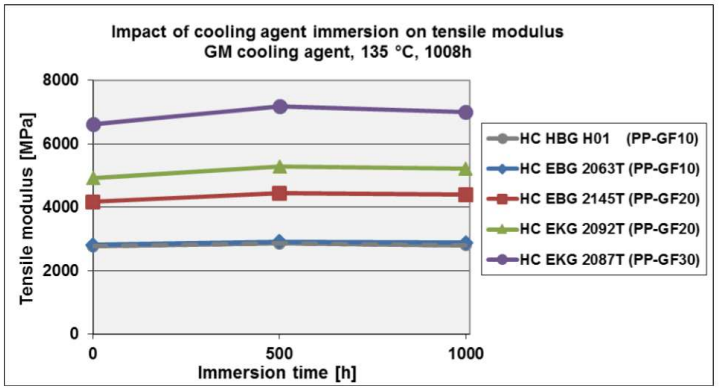
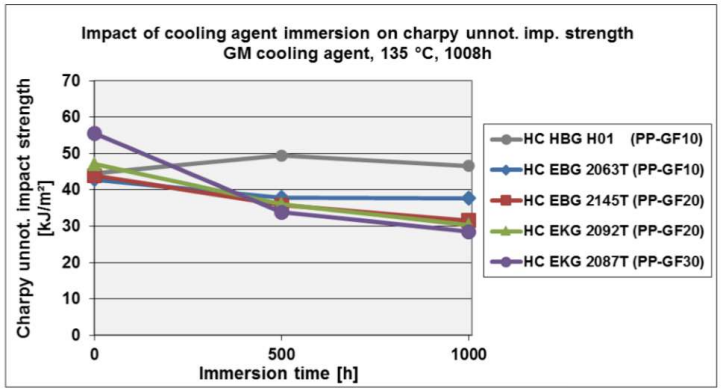
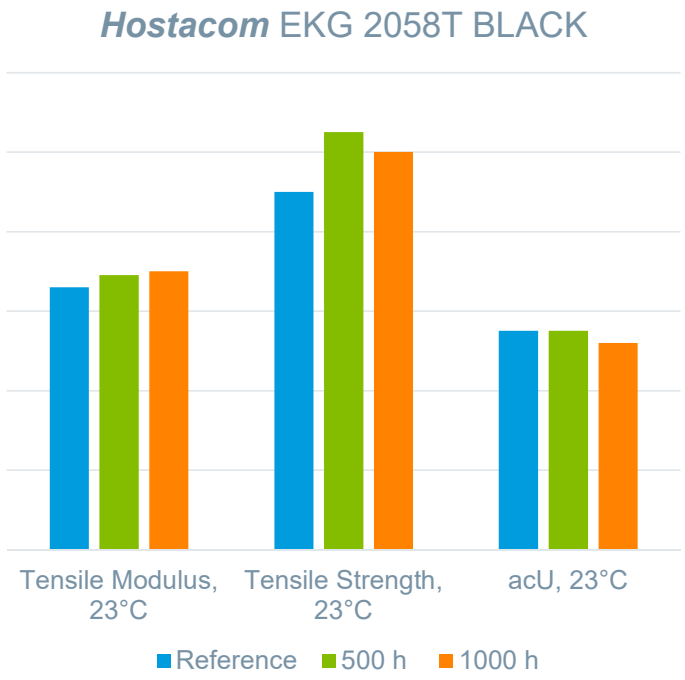
Material evaluation – exposure in coolant or heat

Immersion test result in GMW 3420 coolant, 130°C





Mechanical properties after 500 h and 1000h at 150°C (exposure to hot air)



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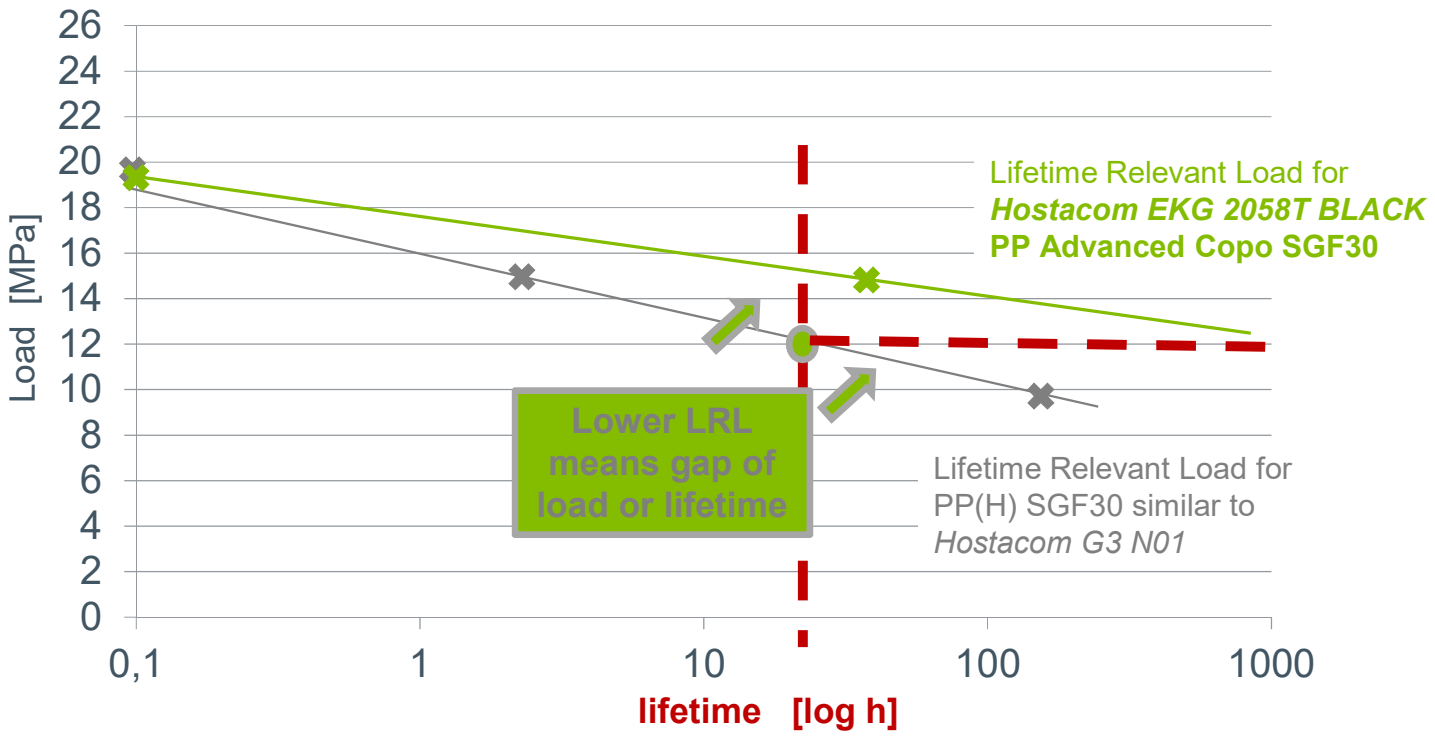
Material evaluation – lifetime expectation due to permanent load

Example / Test results:

- Tensile creep test performed at **120°C** on injection molded specimen (test longitudinal to fiber direction)
- Different loads applied, time measured to failure (✖) to get the acc. pairs of values
- "time to failure" of a material (at certain load and certain temperature) can be described as "(expected) lifetime"
- "load / lifetime" correlation can be described as "Lifetime Relevant Load" (LRL)



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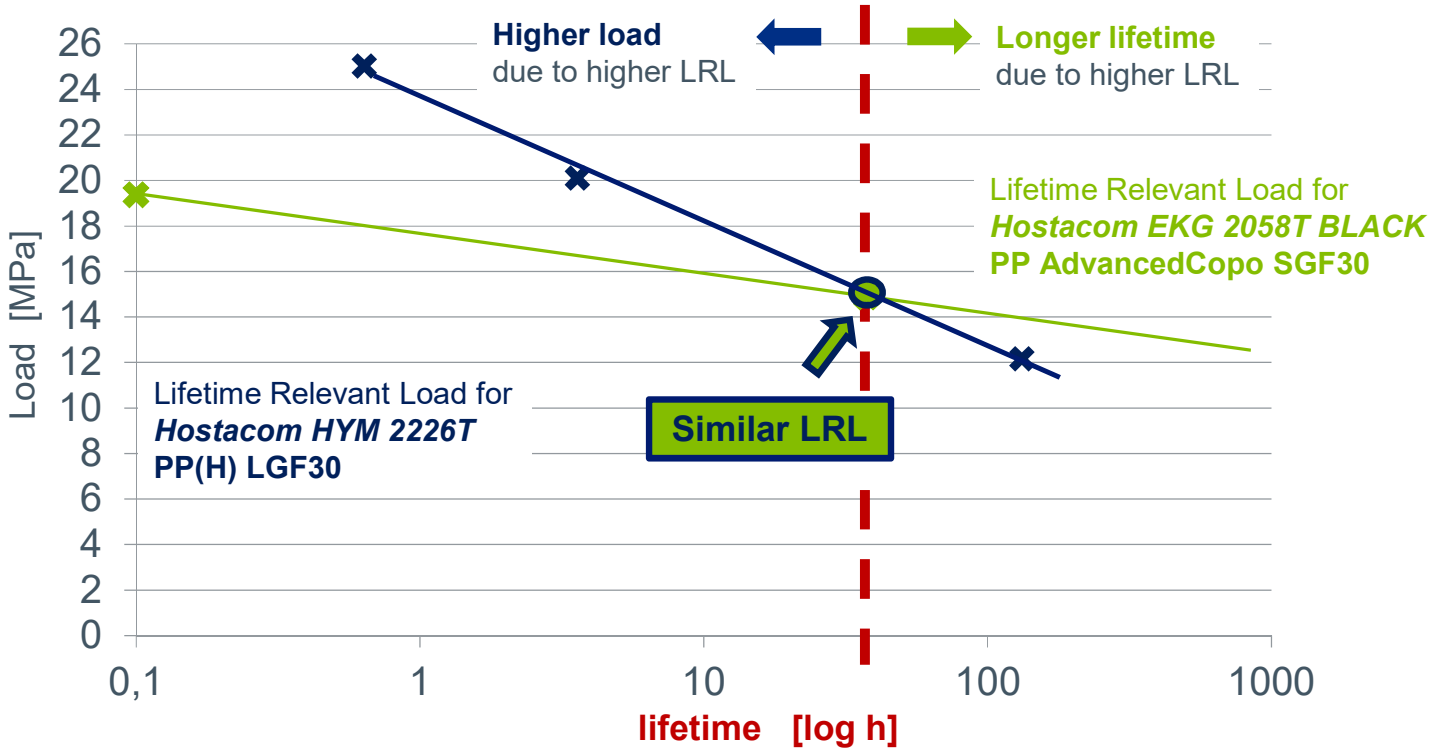

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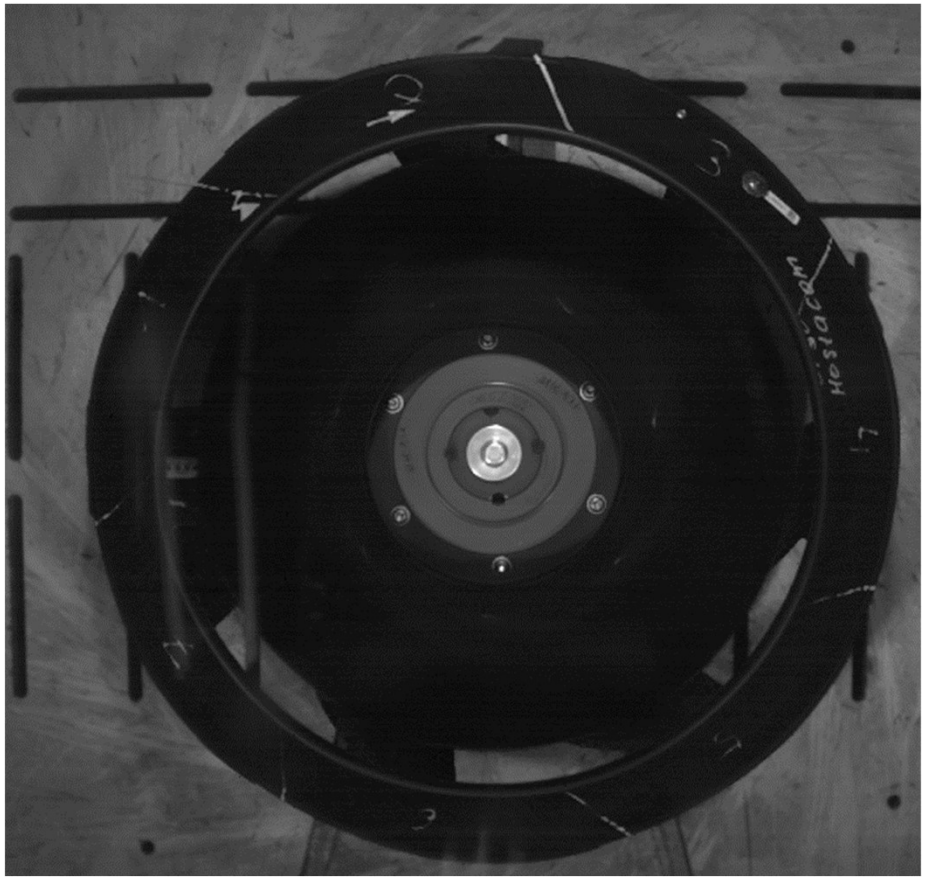
Material evaluation

lifetime test video with combined undercranking and slow motion effect.



Source: ZiehlAbegg

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Material evaluation – lifetime expectation due to permanent load

Recipe characteristics				HHF-SGF30	AC-SGF30	HHF-LGF30
Properties	Symbol	Method	Unit			
Ash (1h / 625 °C)	-	ISO 3451/1	%	**31,77**	**30,15**	**30,53**
Tensile test at 23 °C		ISO 527-1, 2				
one end injection						
Tensile stress at yield	σ_y		MPa	**85,9**	**109,2**	/
Tensile strain at yield	ε_y		%	**2,1**	**3**	/
Tensile stress at break	σ_B		MPa	**84**	**108,3**	**124,3**
Tensile strain at break	ε_B		%	**2,5**	**3,4**	**2,4**
Tensile modulus	E_t		MPa	**6398**	**6788**	**6711**
Tensile test at 23 °C		ISO 527-1, 2				
two ends injection						
Tensile stress at yield	σ_y		MPa	/	/	/
Tensile strain at yield	ε_y		%	/	/	/
Tensile stress at break	σ_B		MPa	**40,6**	**41,2**	**37,4**
Tensile strain at break	ε_B		%	**1**	**1**	**0,8**
Tensile modulus	E_t		MPa	**4947**	**4946**	**4896**

- 52%

- 62%

- 70%

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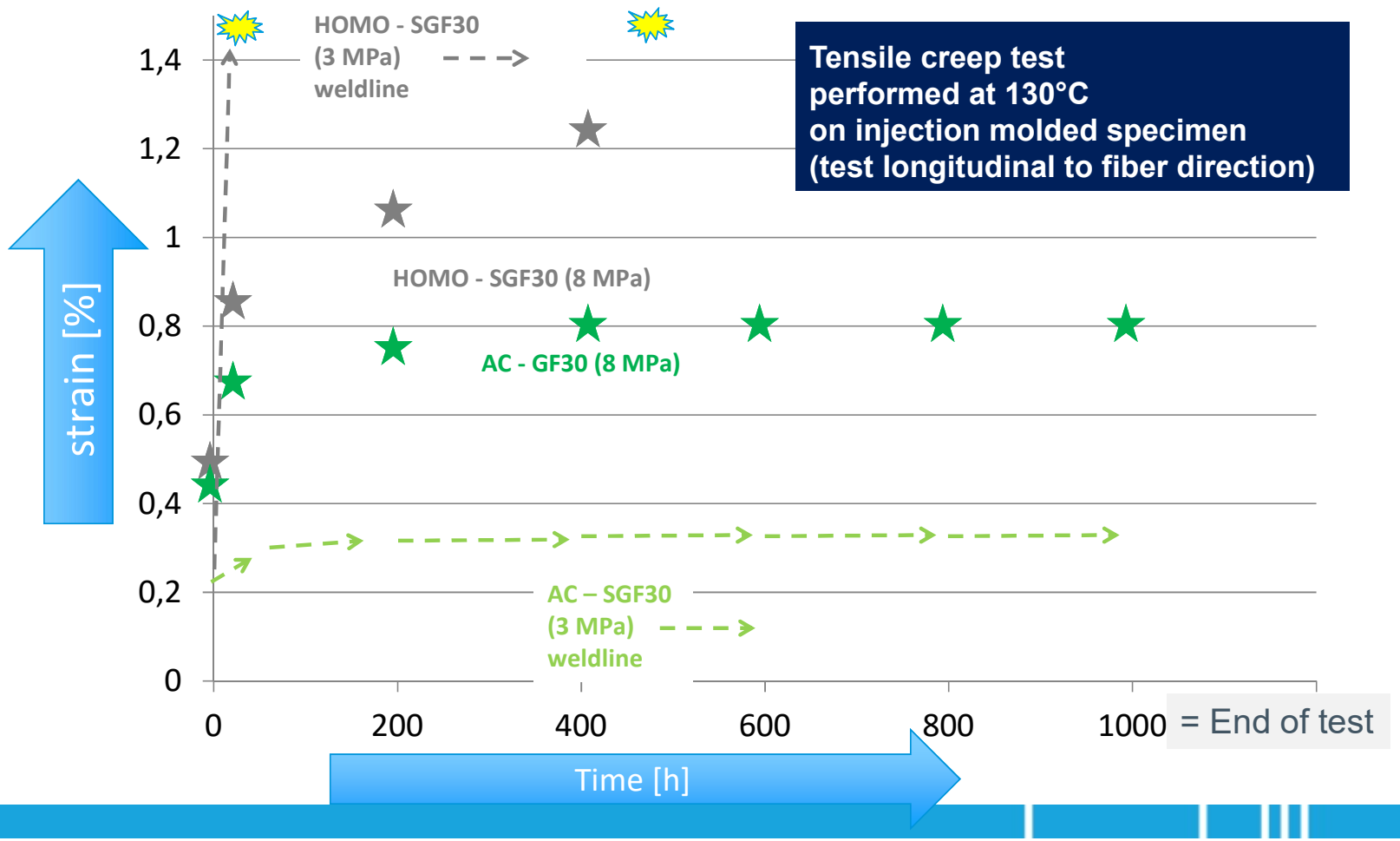
Material evaluation – lifetime expectation due to permanent load



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