Flame-retardant PP materials (halogen- and PFAS-free) for household appliances and electronic components

Dominik Haselwanter

Introducing Borealis

Key facts and figures

120
Countries. Head Office in Vienna, Austria

6,200
employees worldwide

Production and distribution of advanced and circular polyolefins solutions and base chemicals

Ownership structure:

75%
OMV, Austria

25%
ADNOC, United Arab Emirates

Our JV's: Bayport Polymers (Baystar™) – brings Borstar® technology to American polyethylene markets

Our JV's: Borouge – one of the world's largest integrated polyolefin complexes (Ruwais, UAE)

#2
Among polyolefin producers in Europe

EUR 566 million
net profit

121
Priority patents filed in 2024

5
Polyolefin recycling operations in Europe

Where to find us

Borealis Locations

Head Office
Borealis AG
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Fax + 43 1 22 400 333
www.borealisgroup.com
info@borealisgroup.com

Customer Service Centers
Austria, Belgium, Finland, Türkiye, United States

Production Plants
Austria, Belgium, Brazil, Finland, Germany, Italy, South Korea, Sweden, The Netherlands, United States

Recycling Plants
Austria, Belgium, Bulgaria, Germany, Italy

Sales Offices/Representative Office
Argentina, Brazil, Chile, China, Colombia, Croatia, Czechia, France, Mexico, Morocco, Poland, Romania, Slovakia, South Africa, Spain, Türkiye, UAE, UK

Innovation Centers
Austria, Finland, Sweden

Borouge Locations

Head Offices
UAE, Singapore

Innovation/Application Center
UAE/China

Production Plants
UAE, China

Sales Offices/Representative Offices
China, Egypt, India, Indonesia, Japan, Singapore, Thailand, UAE, Vietnam

Logistics Hubs
China, Malaysia, Singapore, UAE

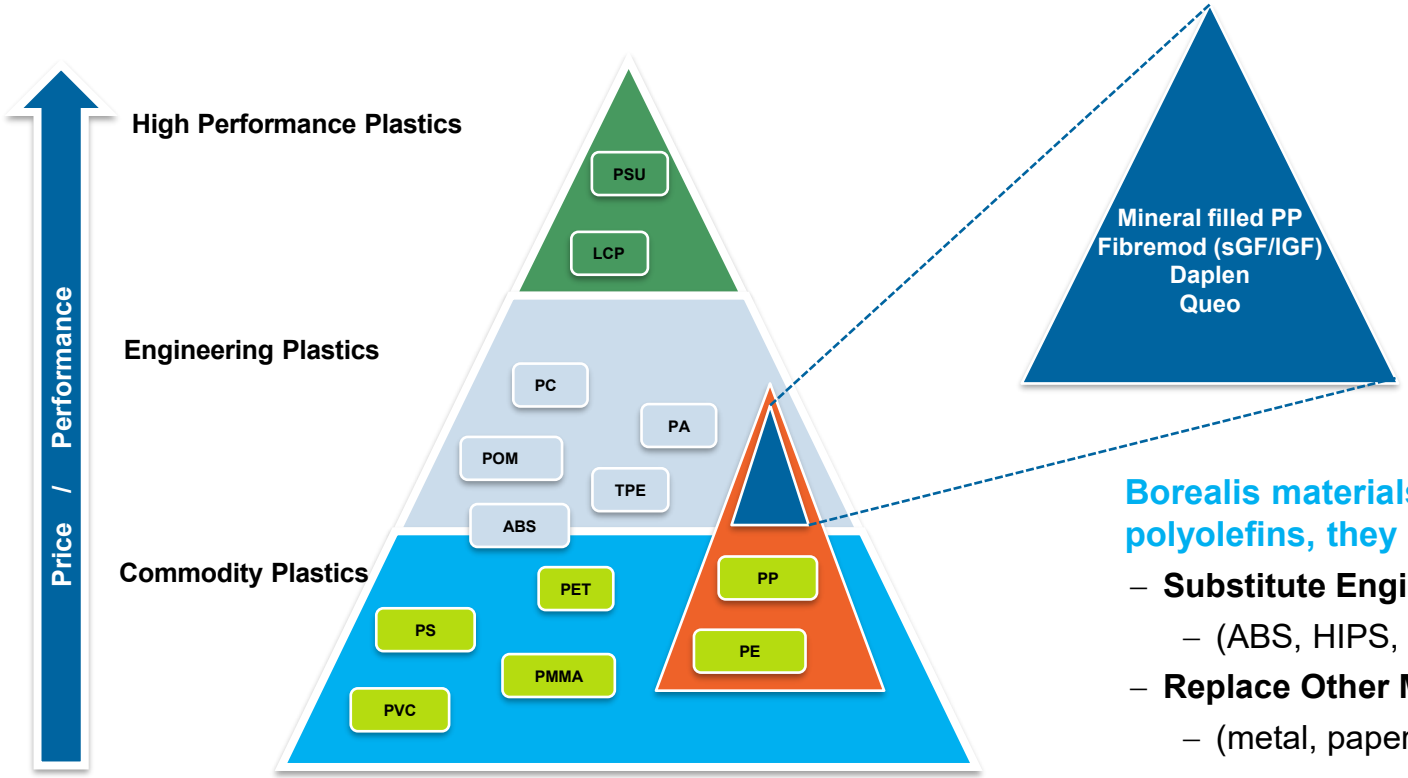
The purpose of this visualization is of representational nature only. Though it was prepared with the greatest possible attention to detail, simplified illustrations may have been applied.

Who we are

We serve advanced polyolefins for virgin and circular economy solutions for these industries

- Healthcare
- Appliances
- Structured Products
- Oil & Gas
- Concentrates and Modifiers

Borealis materials can match properties of engineering plastics

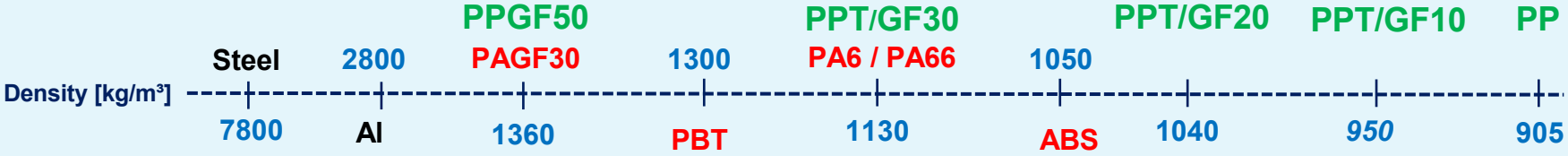


Borealis materials are not just standard polyolefins, they can also:

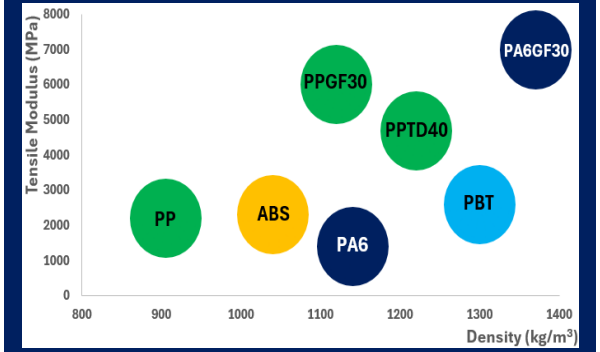
- **Substitute Engineering Plastics**
  - (ABS, HIPS, PA6)
- **Replace Other Materials**
  - (metal, paper, aluminium)

…while offering multiple benefits

Addressing light-weight in appliance & structured applications



Great stiffness:density ratio



Low Process Complexity with PP

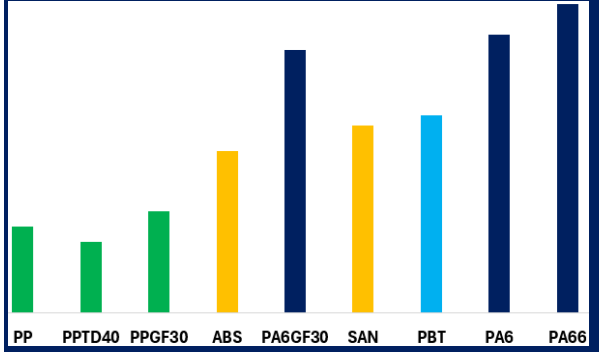
PP has low melt and mould temps

No Drying needed

No moisture absorption

Quick cycle times

Best in class CO2 emissions



Flame-retardant PP materials

Background & motivation

- PP FR materials had limitations in the past decades and a limited use in Electronics
  - Brominated solutions with Antimon exist since decades but have regulatory limitations for future growth
  - High FR loadings were necessary to achieve UL94 flammability at 1.6 or 0.8mm thickness
  - RTIs usually not given for PP FRs

- The change to electric vehicles has changed the dynamics for PP FRs
  - FR manufactures have started to develop new halogen-free FR systems with better performance
  - Lower loadings are achievable without needing brominated FR system
  - PFAS additives can be avoided with the right technology

- Borealis has developed a broad FR portfolio (halogen- and PFAS-free)
- And Borealis continue to develop further materials to enable usage in appliances and E&E applications

Ban of PFAS proposed by European CHemicals Agency (ECHA)

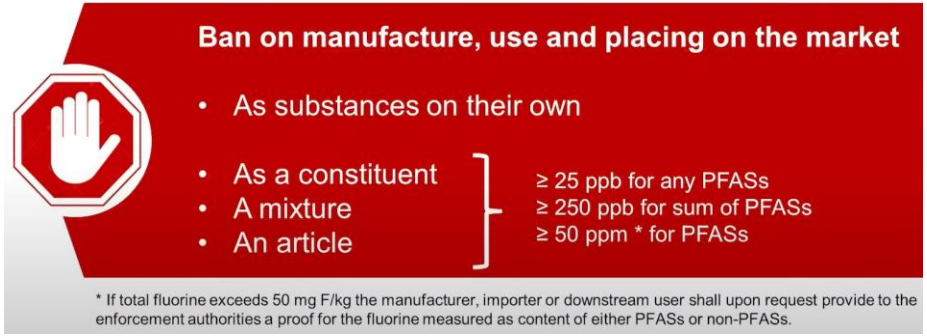
Proposal from January 13, 2023:
Ban of all PFAS with transition periods ranging from 18 months to 12 years

Derogation considered for very specific combination of use sector + use only.
If your use is not explicitly mentioned, the restriction applies!

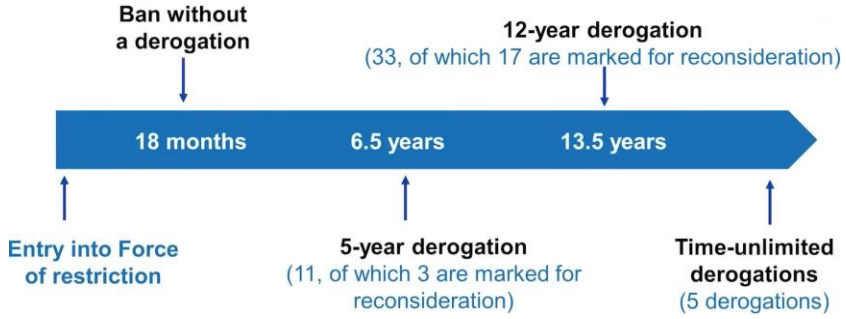
End of consultation period on September 25, 2023:
> 5600 comments to ECHA for check

Enforcement Forum’s **advice on enforceability** released **on November 8, 2023**

Further details:
https://echa.europa.eu/de/hot-topics/perfluoroalkyl-chemicals-pfas



Phase out timeline and derogations in original proposal:



Borealis flame retardant PP compounds

Wide range of halogen-free compounds

Grade name	MFR (g/10min)	Filler content	GWFI (°C)	Tensile Modulus (MPa)	Charpy NIS 23°C (kJ/m²)	Charpy IS -30°C (kJ/m²)	UL94 rating	CTI (V)	Halogen free	UL listing
FE020HP	12	0	960	2100	3	21,5	V-0 at 1.5mm V2 at 0.8mm	≥ 600	Yes	Yes
FE121SF	14	10% GF	960	3627	7	29,5	V-0 at 1.5mm V2 at 0.8mm	≥ 600	Yes	Yes
FD221SF	5	25% GF	930	5838	10	40,3	V-0 at 1.5mm V2 at 0.8mm	≥ 600	Yes	Yes
FF311SF	16	30% GF	960	8540	9	40	V-0 at 1.5mm V2 at 0.8mm	≥ 600	Yes	Yes

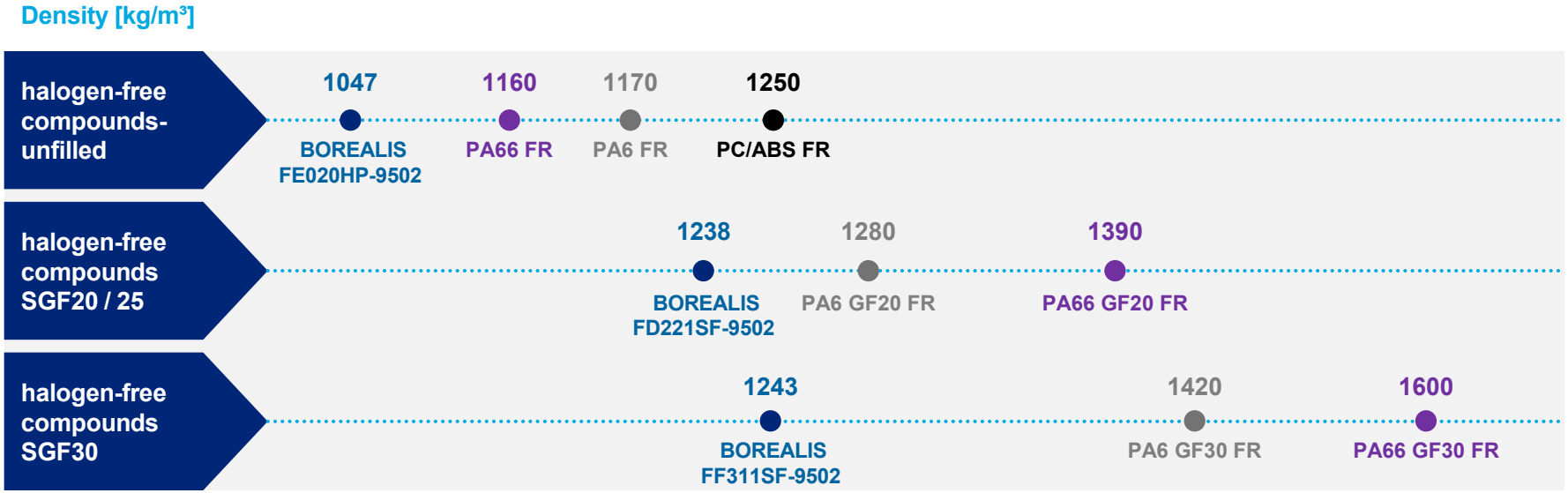
Values determined on standard injection moulded specimens conditioned at 23°C and 50% relative humidity after at least 96 hours storage time.

- Halogen-free and **PFAS-free**
- V-0 at ≥ 1.5 mm wall thickness (UL 94)
- Complementing the mechanical performance range of our existing HFFR portfolio
- Colors and laser welding ability possible on request

Special solution for FR applications

Benefits - PP vs other engineering plastics

- Using PP instead of PA or PC enables cost saving per part of up to 25%
  - Potential lower raw material purchasing price/kg
  - Lower volume required due to lower density
  - Lower production costs due to approximately 20% energy saving (no conditioning, lower melt)
- Savings in potential CO_2 taxes, as PP shows best in class CO_2 footprint

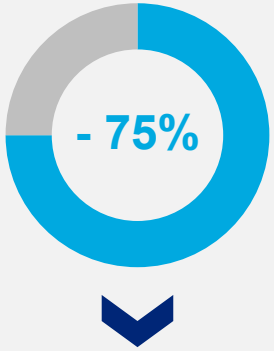


Special solution for FR applications

Reduced environmental impact

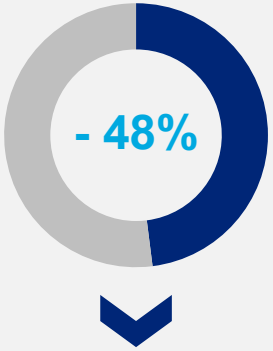
Polypropylene vs. Polyamide

CO_2



75% less CO_2 emissions during production of PP vs. PA

ENERGY DEMAND



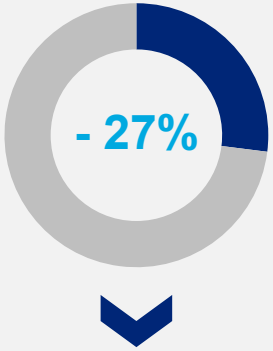
48% less energy consumed during production of PP vs PA

Polypropylene vs. Polycarbonate/ABS

CO_2

50% less CO_2 emissions during production of PP vs PC/ABS

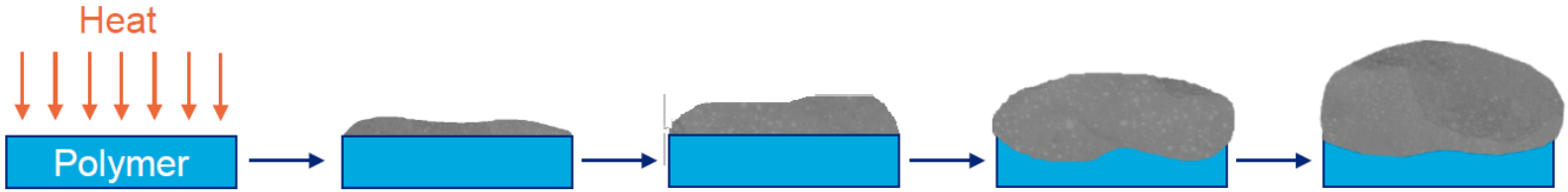
ENERGY DEMAND

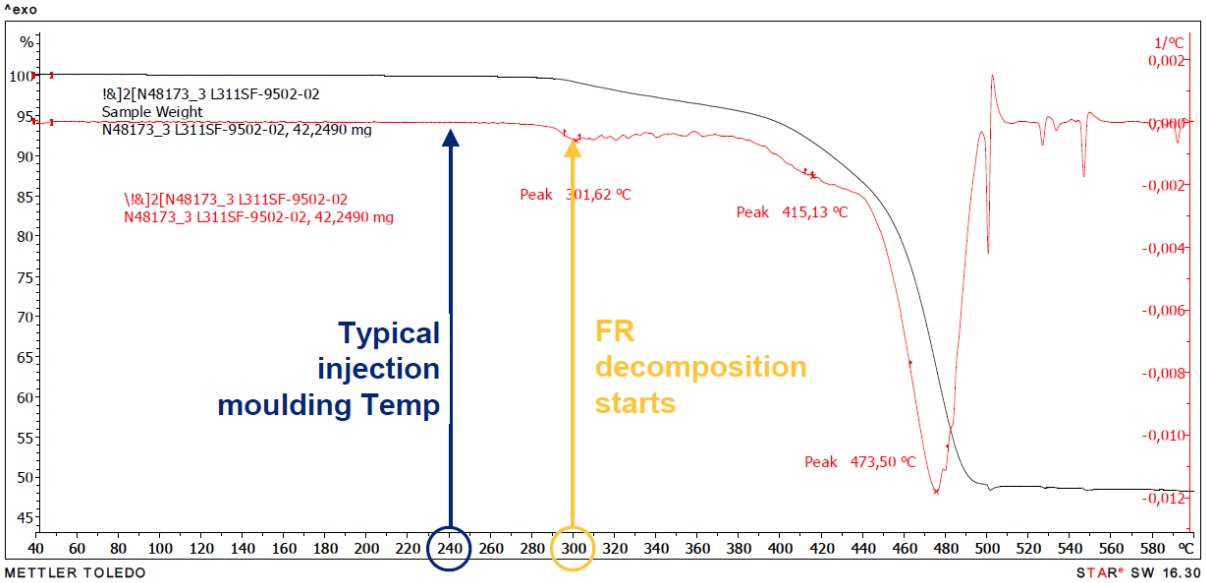


27% less energy consumed during production of PP vs PC/ABS

Sources: Plastics data: ecoprofiles Plastic Europe, IPCC. Researchgate.

Mechanism of our FR PP grades





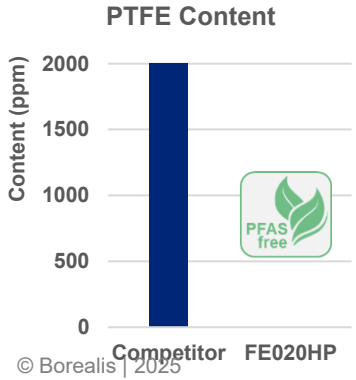
- FR system reaction triggered at temperatures > 300°C
- Intumescence is defined as the process of swelling and char formation
- The intumescent char acts as a barrier towards the flame

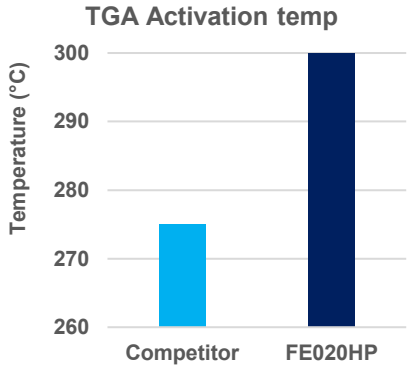
Unfilled PPFR Solution

Low to no mold deposit

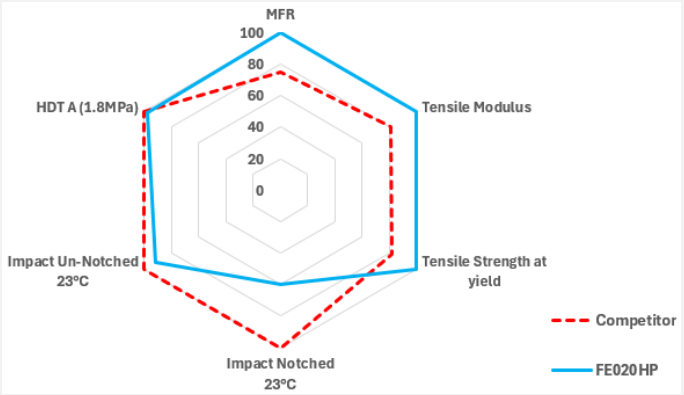
Comparison vs industry known competitor grade

- Both materials have
  - V0 rating at 1.5mm
  - CTI value is 600V
  - GWFI at 3mm of 960°C
  - GWIT value at 3mm of 850°C
- The competitor shows earlier formation of acidic by-products causing sever chemical attack and quicker tool degradation.
- FE020HP shows signs of the by-product release after 30minutes at 300°C while competition at 200°C and 20minutes.





Mould residuum when moulding competitor material



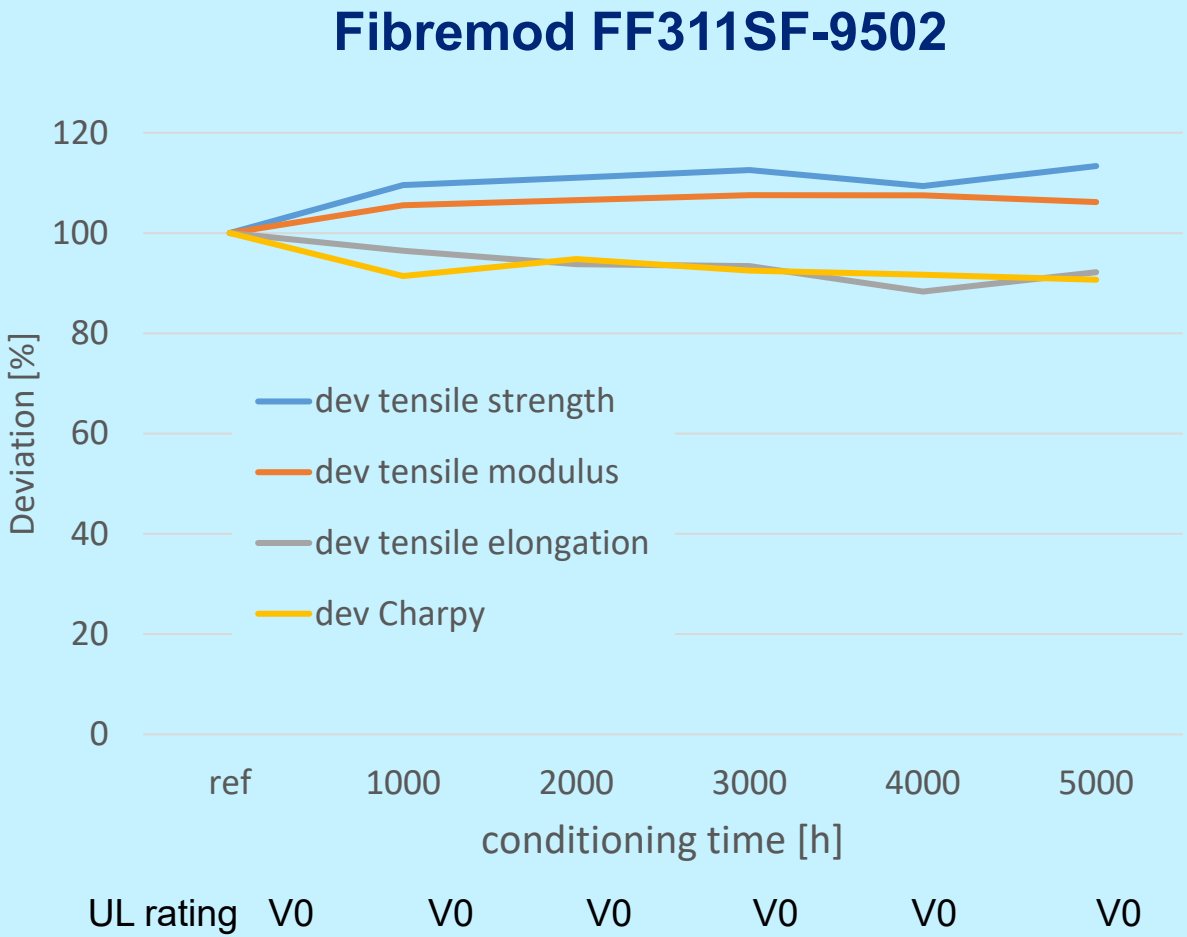
Benefits over competitor

- ✓ FE020HP does not contain any PTFE
- ✓ FE020HP shows decreased tool degradation level due to later chemical release at higher temperature
- ✓ FE020HP has higher activation temperature giving broader processing window

Long-term temperature stability

High temperature stability of mechanical and FR properties even after 5000h of ageing at 120°C

- 5000 hours conditioning at 120°C
- Mechanical performance remains mostly unchanged
- V0 performance remains even after 5000 hours of testing (UL 94 test)



Value proposition PP FR

Borealis PP FR Portfolio

- Halogen and PFAS free system meeting future demands
- Full yellow card (all colors, RTI)
- High CTI
- Very stable processing

vs. Engineering plastics

- Cost advantage vs. PA, PBT, PC
- Lower density (cost / part)
- Easier processing (lower temperatures, low mold deposit)
- Lower CO2 footprint

Component - Plastics
FF311SF-XXXX
Yellow Card™

BOREALIS POLYOLEFINE GMBH
ST PETERSSTRASSE 25
LINZ, 4021 Austria

File Number: E108112

Fibremod: FF311SF-XXXX

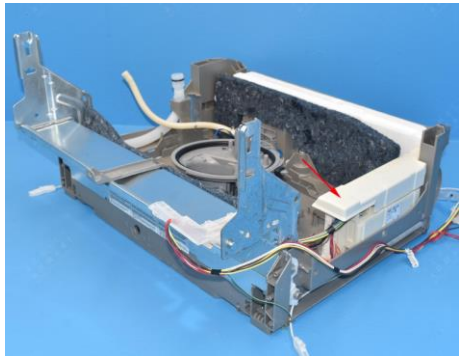
Polypropylene (PP), glass reinforced, pellets
NOTE - Material designation is followed by a four digit number indicating color.
XXXX - To be replaced by four digits indicating color

ALSO CERTIFIED TO IEC REQUIREMENTS

Flammability	Value	Test Method
Flame Rating		UL 94 IEC 60695-11-10, -20
0.8 mm, ALL	V-2	
1.5 to 1.7 mm, ALL	V-0	
Glow Wire Ignition Temperature (0.8 mm)	800 °C	IEC 60695-2-13
Electrical	**Value**	**Test Method**
Comparative Tracking Index	600 V	IEC 60112
Thermal	**Value**	**Test Method**
RTI Elec		UL 746B
0.8 mm	65.0 °C	
1.5 to 1.7 mm	65.0 °C	
RTI Imp		UL 746B
0.8 mm	65.0 °C	
1.5 to 1.7 mm	65.0 °C	
RTI Str		UL 746B
0.8 mm	65.0 °C	
1.5 to 1.7 mm	65.0 °C	

New PP FR developments

- Critical to develop the market for household appliances and electronic components:
  - UL94 V0 (0.8mm) classification
  - UL94 5VA (2mm) classification
  - RTI of 120°C for yellow card



Borealis market approach

- We are looking for partners who are interested in replacing engineering plastics or other PP FR materials
  - In existing applications
  - In new applications
- PP behaves differently and limitations must be understood
  - Weldlines are weaker vs. PA
  - Creep and fatigue can be worse
  - Continuous usage at 120°C with peak Temperatures up to 150°C is possible

- However, taking these aspects into account, PP FR offers many advantages and high added value, therefore...

Thank you!

Let’s re-invent!

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