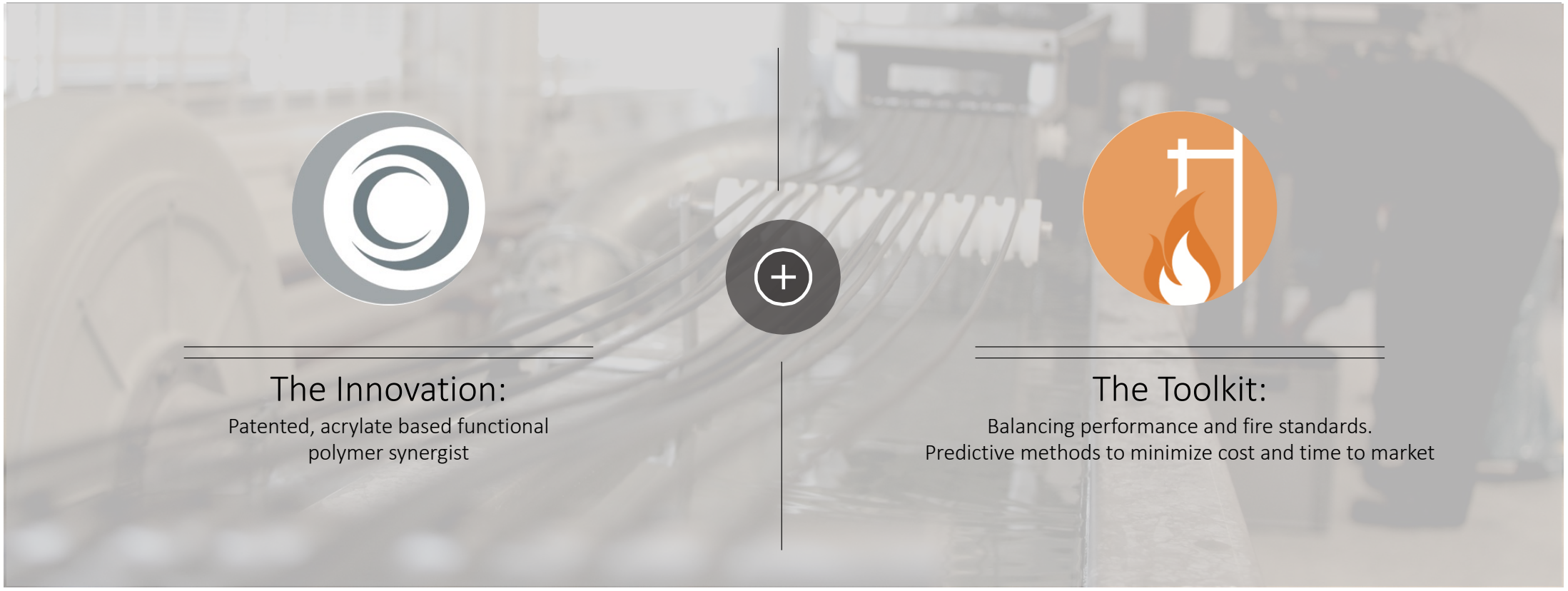
Paxymer

Paxymer: Unique FR Approach for Industrial Solutions

Paxymer has designed a unique approach centered around its patented technology and deep know-how within flame retardant design



The Innovation:

Patented, acrylate based functional polymer synergist

The Toolkit:

Balancing performance and fire standards.
Predictive methods to minimize cost and time to market

Paymer is a family owned company with over 40 years of experience in technology implementation within polymers and 10 years in the field of green flame retardants.

Paxymer is a novel approach to improving fire safety.

Paxymer offer a multi-mechanistic approach. The technology is patented globally and based on functional polymers to be combined with intumescent and mineral systems.

Smoke formation

Low smoke. Low smoke density and toxicity is critical to enable escape.

Reducing levels of FR will decrease smoke. Paxymer does not create asphyxiant gasses.

Fire spread / Combustion

Dripping and high heat will spread the fire.

Paxymer acts as an anti-dripping agent. The mechanism will also reduce the combustion value of the material and the fire spread.

Ignition / Heat

Preventing ignition through self-extinguishing.

Paxymer's condence phase mechanism increased gas phase activity of the P/N system. Enabling extinguishing at lower wt%

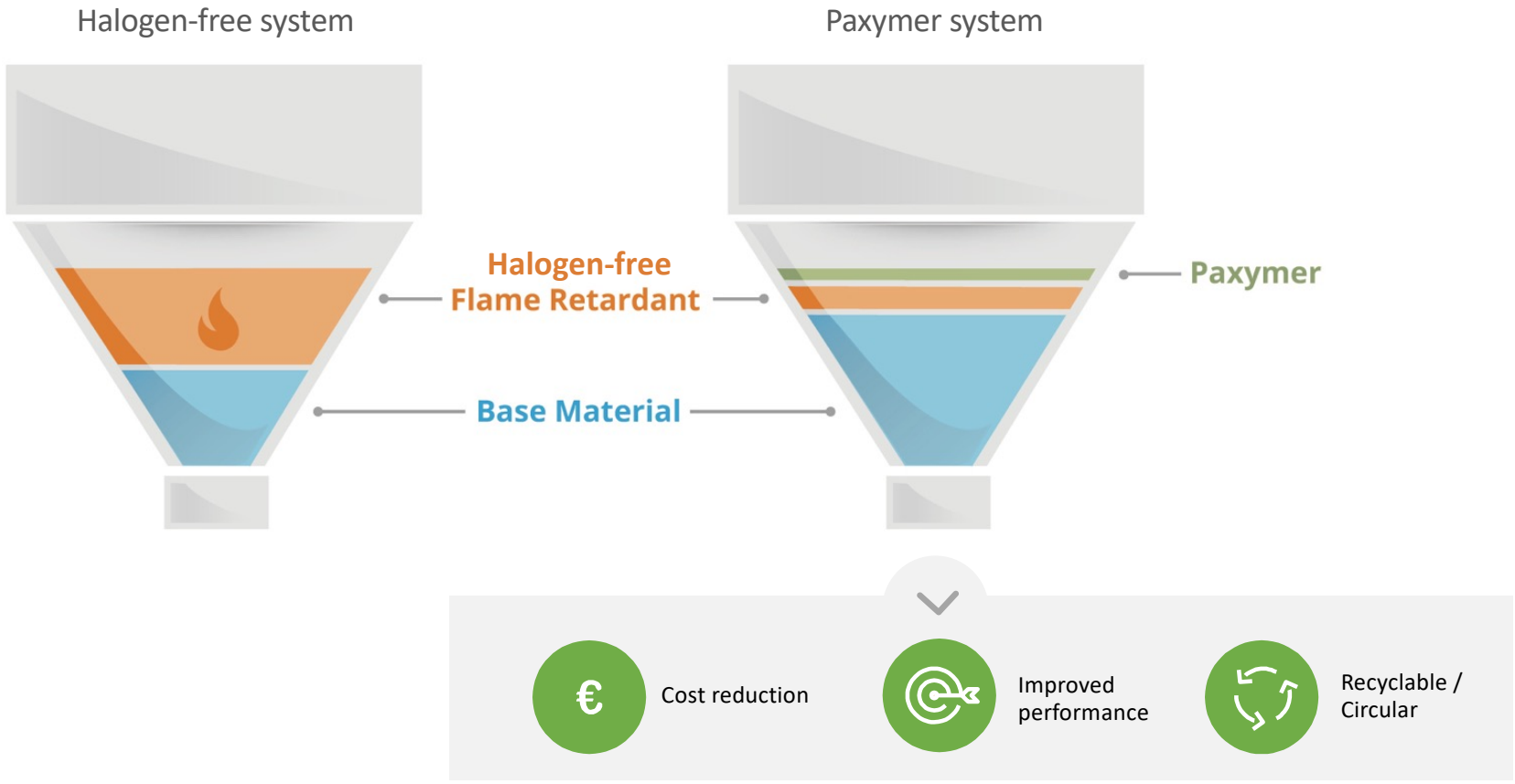
Degradation into fuel

Creates a layer of char that protects the plastic from the flame.

Paxymer reinforce the char and make it more dense and flexible – it provides better protection to the rest of the sample.

Reduces Cost by up to 25% Making Halogen Free Competitive

Reduction in flame retardant dosage improve performance and cost. Halogen-free enables recycling.



General processing notes

- Gentle screw design. Sufficient dispersion/distribution with minimal shear.
- Gravimetric feeding should be utilized. Paxymer BGMB62 should be fed with the base material in the main feed port.
- The P/N derivative should be fed through the side feeder for optimal results
- Both strand and die facing cutting will give good results.
- Good control of shear will result in good strand quality. Early signs of degradation indicating that lower shear has to be obtained:
  - Soapiness of strands,
  - ammonia smell,
  - die drool or
  - yellowing
- Degassing/venting is important to ensure good product quality and low moisture content. Insufficient degassing will manifest in porous strands and influence FR behaviour.
- Temperatures should remain below 240 degC as a target for P/N formulations. Unnecessary residence time and dead spots where material gets stuck should be avoided.
- Paxymer BGMB62 is stable up to 280 degC with limited shear sensitivity.

Paxymer

General formulation notes

- Paxymer is functional polymers that allow for better fire performance or reduction of intumescent systems loading.
- Loading level reduction guidelines:
  - An expected reduction of 3-7% on addition of Paxymer in APP-based systems.
  - An expected reduction of 3-6% on addition of Paxymer in non-APP systems.
- Paxymer loading levels in compounds:
  - For thinner materials the recommended dosage Paxymer BGMB62 is 1%.
  - For thicker materials the recommended dosage Paxymer BGMB62 is 2-3% Paxymer (never exceeding 4%).
- Paxymer can replace PTFE as an anti-dripping agent with retained lower IFR performance.
- Dispersion is critical to achieve good FR properties. However shear has to be controlled.
- Generally: lower MFI base polymers will yield better results at lower dosage of FR. This is especially important to consider when working in fibre-reinforced compounds and selection of the carrier resin.
- Paxymer is generally compatible with additives and fillers. UV, heat, AO, process aids, impact modifiers generally give expected effects.
- Good results have been obtained combination with glass and wood fibre filled materials.
- P/N derivatives are generally not suitable for using with Talcum or $CaCO_3$. Issues include poor surfaces in production and poor FR performance.

Paxymer

Summary of case study: Notes

- The case studies performed compare P/N derivatives in combination with Paxymer in simple formulations. The aim is to determine the potential for reduction of FR additive/package with retained UL94 rating.
- Compounding was performed on a 26 mm 40L/D twin screw extruder. Specimens moulded on a Arburg machine with 55 tonnes locking power.
- Fire tests were performed according to UL94-V method.
- MFI was determined according to ISO-1133-1997 standard
- Tensile testing was performed according to ISO527-3/1A/25 standard, at a draw rate of 50 mm/min. 3-5 samples of each formulation were tested using a JJ Lloyd M30K Tensile testing instrument using a 30kN load cell. The separation distance between the grips was 115 mm.
- Izod impact tests were performed according to ISO 180-2001 standard on a TMI impact testing machine. The tests were performed at room temperature on notched samples where the notches were created using a CEAST machine. Five samples were tested for each formulation and A 2-foot-pound hammer was used to perform the tests.
- Base material: PP Homopolymer from Borealis. MFI is 8,0 g/10 min at 230˚C

Paxymer

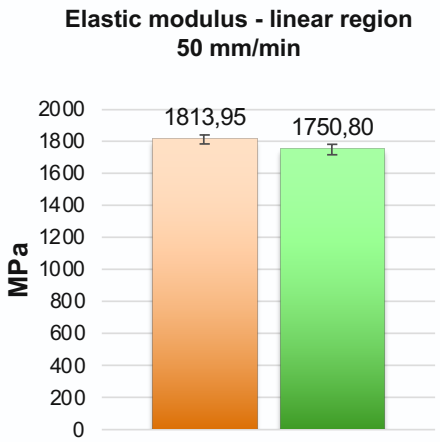
Clariant AP766: Reduces amount of FR additive by 4 wt% with retained UL94-V rating

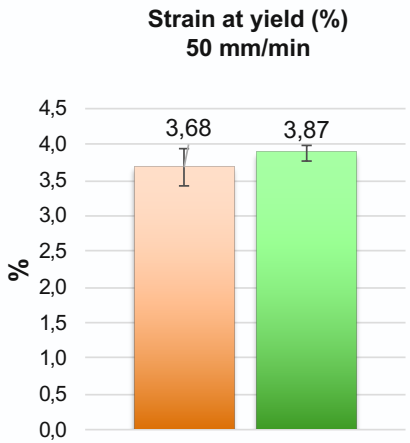
Name	Formulation	UL94-V Rating (2mm)	MFI	Processing
BG605	23% Clariant AP766	V0	5,9	Excellent
BG833	19% Clariant AP766 + 1,1% Pax	V0	7,6	Excellent

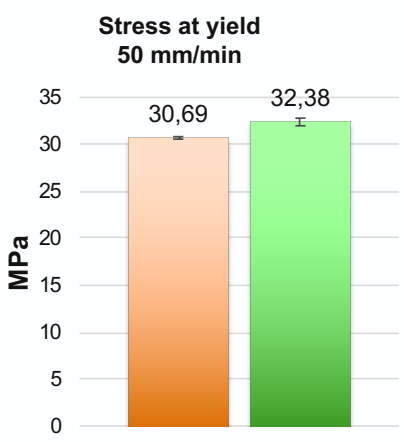
- P/N derivative based on APP + Nitrogen synergist. Formulated system.
- Thermal stability: 260° C. Should be processed with gentle screw design & proper degassing for best results. P/N derivative will give best results when side fed.
- Formulation including Paxymer improves flow compared to the reference. It restores the MFI to the base polymer value.
- **Cost savings potential: 0,31€/kg**

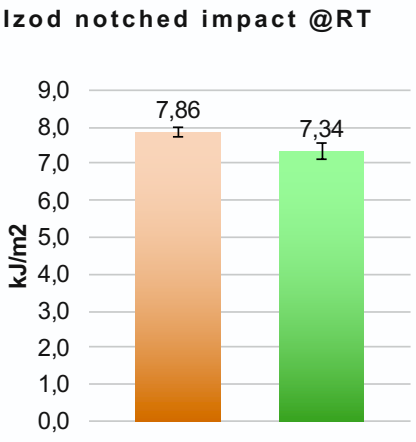
Paxymer

Clariant AP766: Mechanical properties are retained, processing properties and cost is improved









Tensile testing: ISO527-3/1A/25. Izod impact tests: ISO 180-2001

BG605

BG833 (w Paxymer)

Paxymer

Thor PPN978: Reduces amount of FR additive by 6wt% with retained UL94-V rating

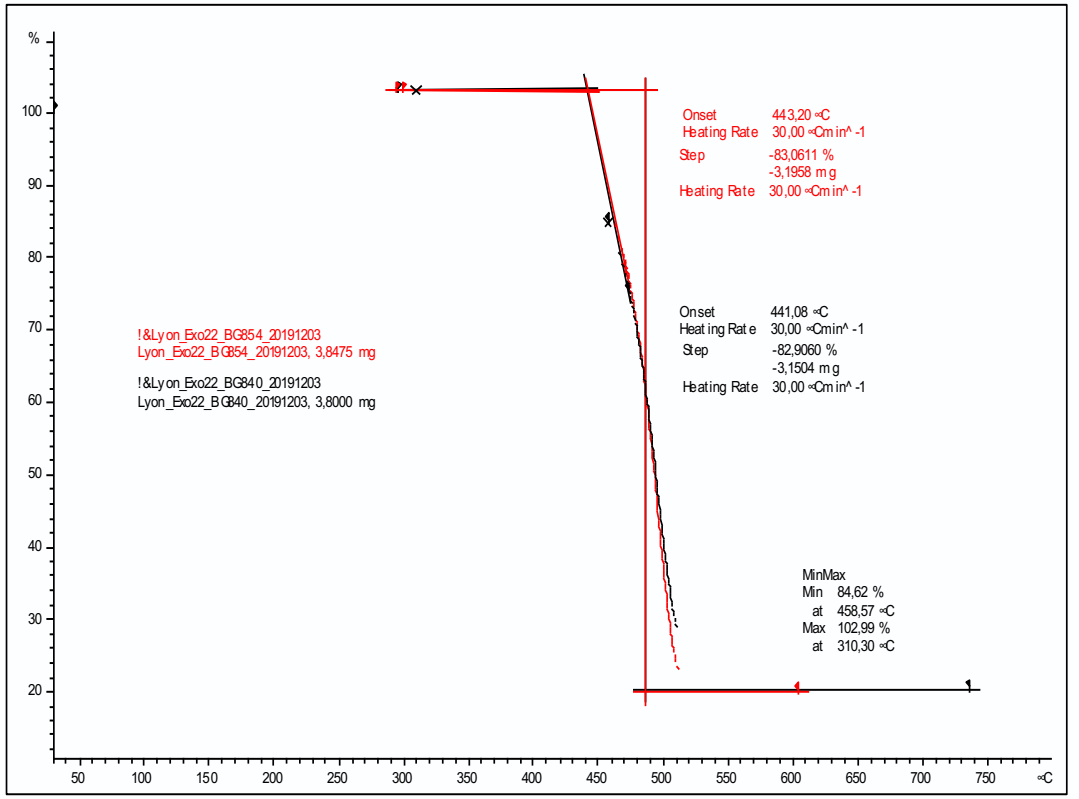
Name	Formulation	UL94-V Rating (2mm)	MFI	Processing
BG840	31% Thor PPN978	V0	4,9	Excellent
BG854	25% Thor PPN978 + 1% Paxymer BGMB62	V0	5,7	Excellent

- P/N derivative based on APP + Nitrogen synergist. Formulated system.
- Thermal stability: <250° C. Should be processed with gentle screw design & proper degassing for best results. P/N derivative will yield best results when side fed.
- **Potential cost savings of 0,48€/kg**

Paxymer

Thor PPN978: Retains onset and ash residue even at lower level of FR.

Name	Air/N_2	T rate (˚C)	T ign	Step 1	
				Onset T (˚C)	%-wt. loss
BG840	N_2	30	515	441	82,9
BG854	N_2	30	519	443	83,1

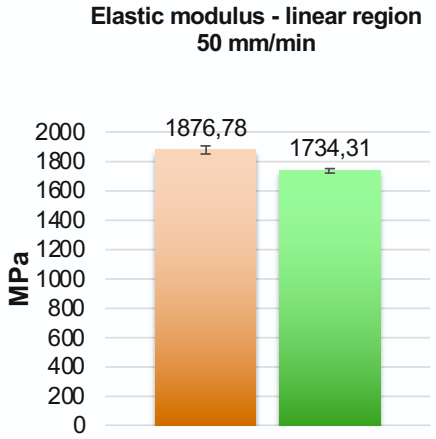


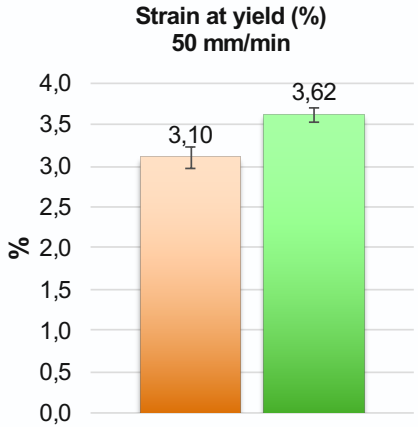
Lab: METTLER

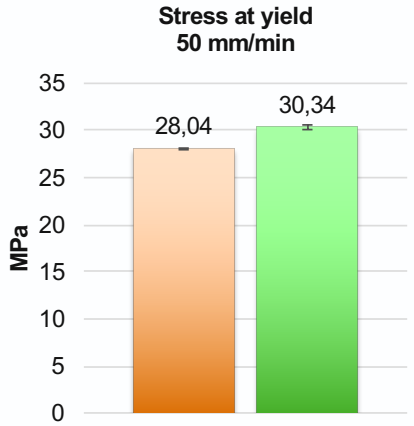
STAR^e SW 9.10

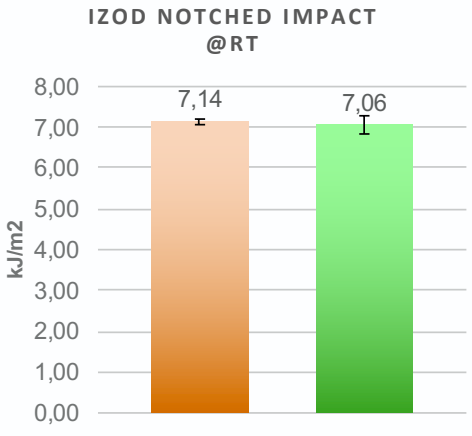
Paxymer

Thor PPN978: Increase in stiffness with retained impact performance at lower levels of FR.









Tensile testing: ISO527-3/1A/25. Izod impact tests: ISO 180-2001

BG840

BG854 (w Paxymer)

Paxymer

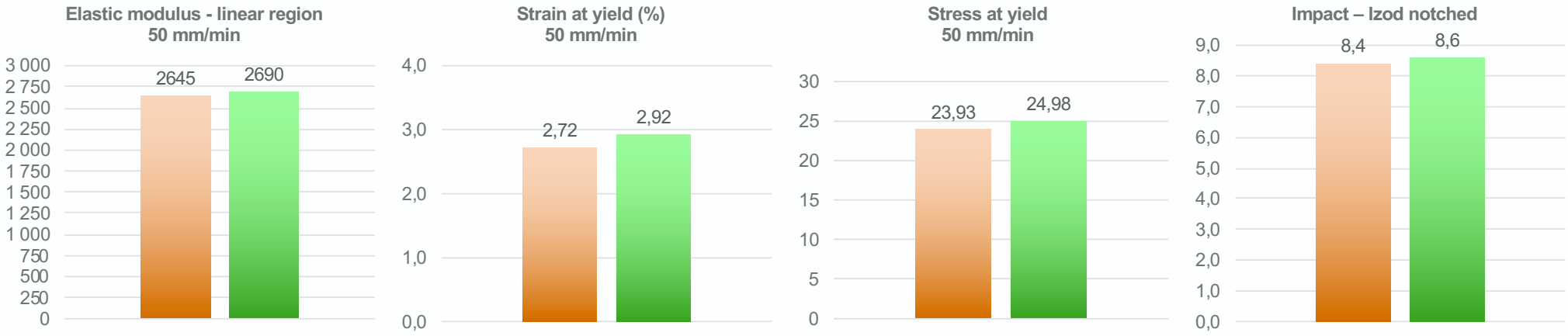
APP type II: Potential to significantly improve on APP formulations utilizing Paxymer's synergist package

Name	Formulation	UL94-V Rating (2mm)	MFI	LOI (%)	Processing
BG443	37% APP type II	V2	5,5	23-24	Poor strands
BG455	25% APP type II + 2% Paxymer BGMB62 + 5% N synergist	V0	7,4	33-34	Excellent

- Standard uncoated APP Type II + N synergist and Payxmer BGMB62
- Thermal stability: <240° C. Should be processed with gentle screw design and proper degassing/venting. P/N derivative will yield best results when side fed.
- LOI and flow of the polymer is drastically improved compared to the reference case.
- Processing is drastically improved by the reduction of additive.

Paxymer

APP type II: Mechanical properties are improved compared to the reference.

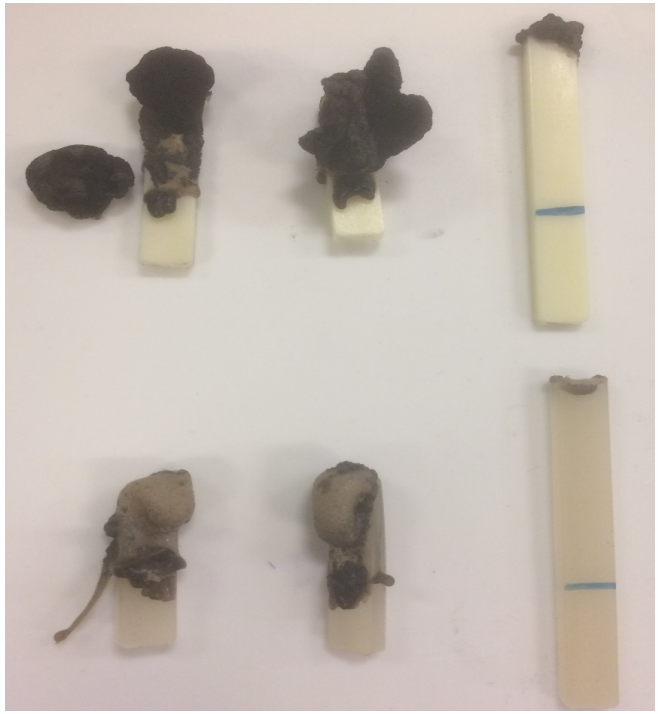


Tensile testing: ISO527-3/1A/25. Izod impact tests: ISO 180-2001

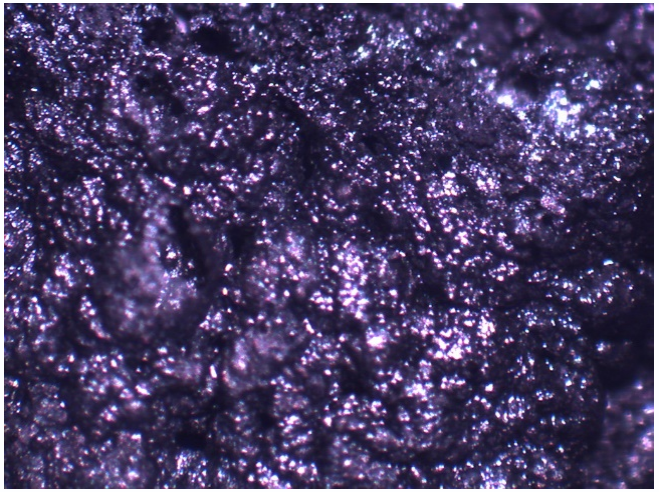
BG443 BG455 (w Paxymer)

Paxymer

APP type II: The Paxymer synergist improves the density and morphology of the char.



Char formation of 37% APP type II (top) and 25% APP-3 + 2% Paxymer BGMB62 + 5% N synergist *(bottom) after burning.*



Char morphology of 25% APP type II + 2% Paxymer BGMB62 + 5% N synergist *after burning (x32 zoom)*

Paxymer

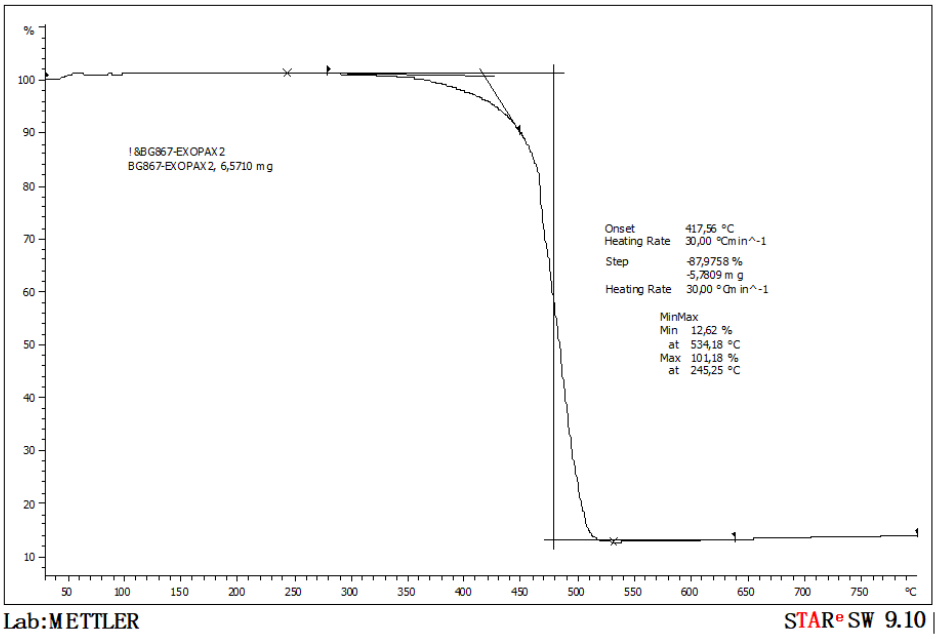
JLS PNA220-A:
4% of reduction possible with retained UL94 rating.

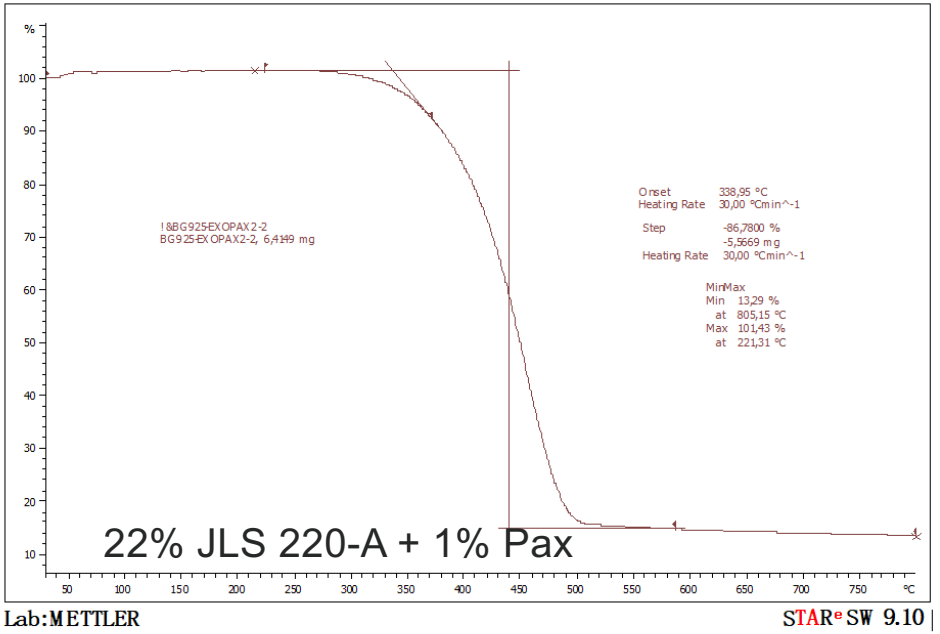
Name	Formulation	UL94-V Rating (2mm)	MFI	Processing
BG867	26% JLS PNA220-A	V0	7,4	Excellent
BG925	22% JLS PNA220-A + 1% Paxymer BGMB62	V0	7,1	Excellent

- P/N derivative based on APP + Synergist. Formulated system.
- Thermal stability: <250° C. Should be processed with gentle screw design and proper degassing/venting. P/N derivative will yield best results when side fed.
- The P/N derivative shows some tendency for bridging and proper feeding equipment should be utilized in order to ensure stable feeding.
- **Cost savings potential: 0,18 €/kg**

Paxymer

JLS PNA220-A: Improves ash residue even at lower level of FR.



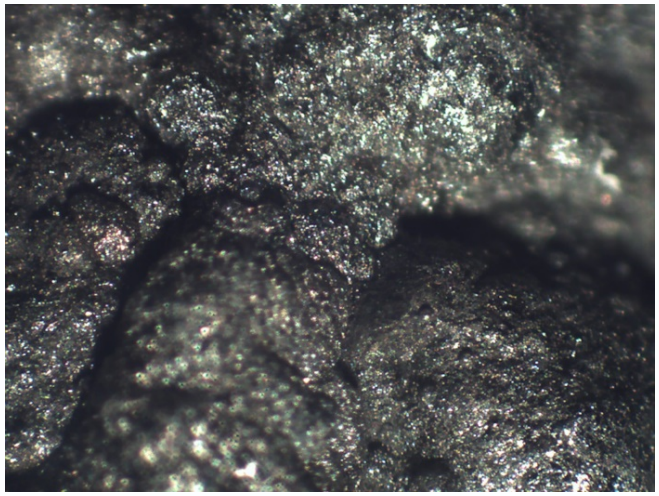


Name	Air/N_2	T rate (˚C)	T $_{ign}$	% Residue
BG867	N_2	30	**500**	12.6
BG925	N_2	30	**467**	14.1

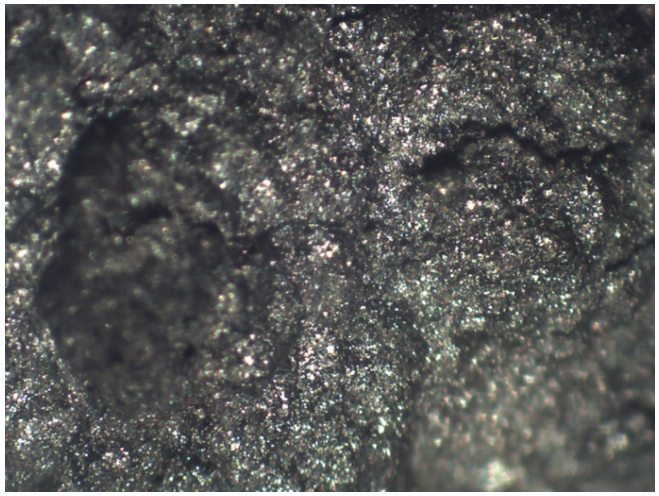
Paxymer

The addition of Paxymer to JLS PNA220-A increases char formation and makes the char denser

Without Paxymer

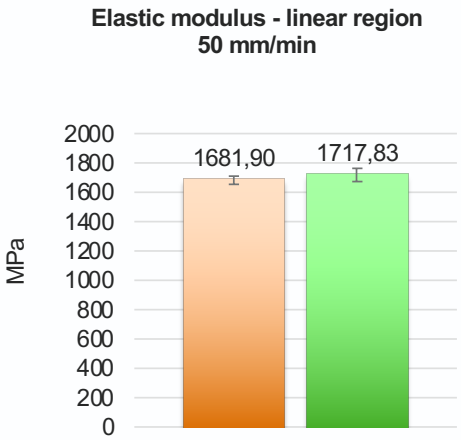


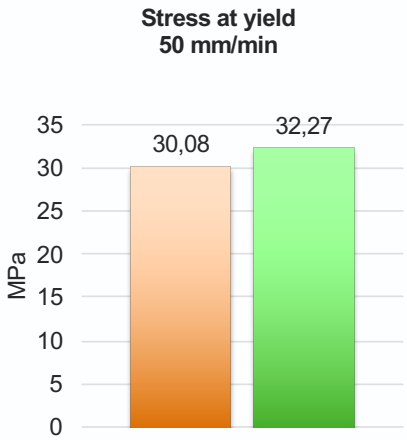
With Paxymer

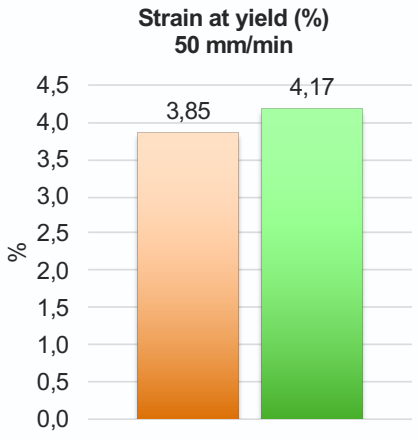


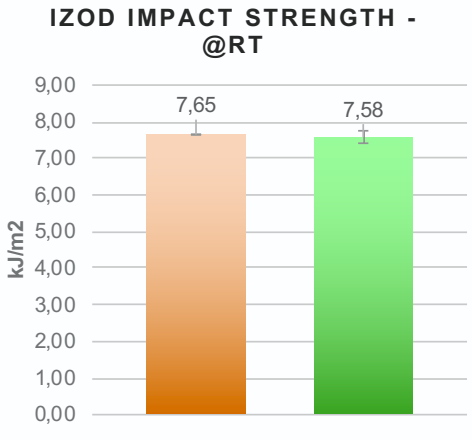
Paxymer

JLS PNA220-A :
Mechanical properties are retained compared to base case









Tensile testing: ISO527-3/1A/25. Izod impact tests: ISO 180-2001

BG867 BG871 (w Paxymer)

Paxymer

Periphnor EPFR110DM: Reduced inorganic content by 2wt%: retained UL94 rating & increased thermal stability

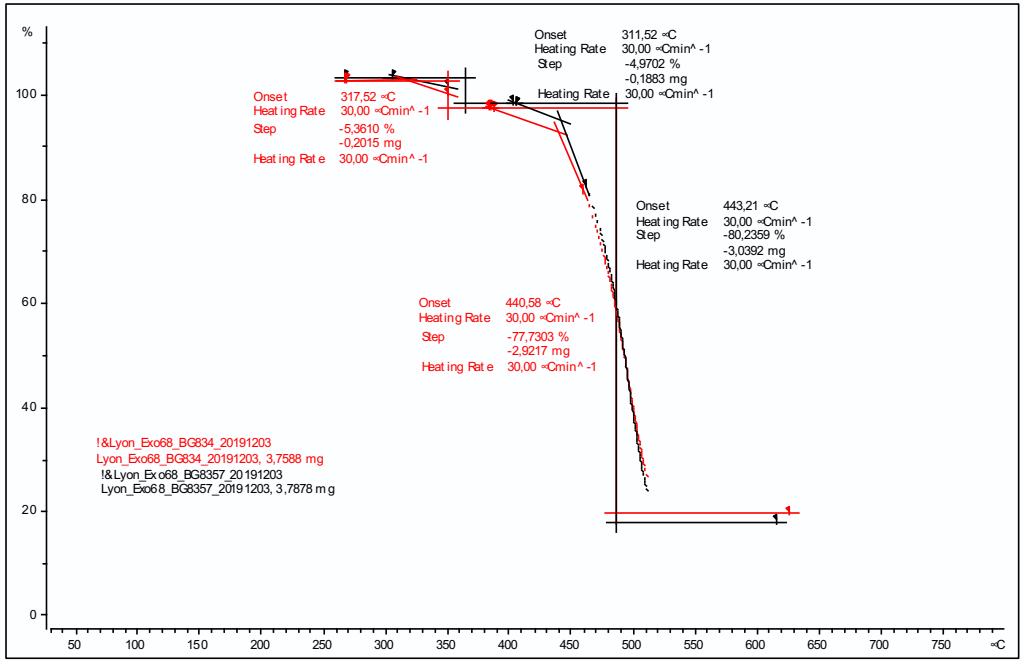
Name	Formulation	UL94-V Rating (2mm)	MFI	Processing
BG834	26% Periphnor EPFR110DM	V0	6,3	Feeding
BG857	24% Periphnor EPFR110DM + 1% Paxymer BGMB62	V0	7,4	

- P/N derivative based on non-APP + Synergist. Formulated system.
- Supplied by Presafer.
- Thermal stability: <250 degC. Should be processed with gentle screw design & proper degassing for best results. P/N derivative will yield best results when side fed.
- The P/N derivative shows some tendency for bridging and proper feeding equipment should be utilized in order to ensure stable feeding.
- The flow of the materials is significantly increased and is almost returned to the base polymer value by including Paxymer.

Paxymer

Periphnor EPFR110DM: Onset is increased during first degradation step & ignition temperature is reduced

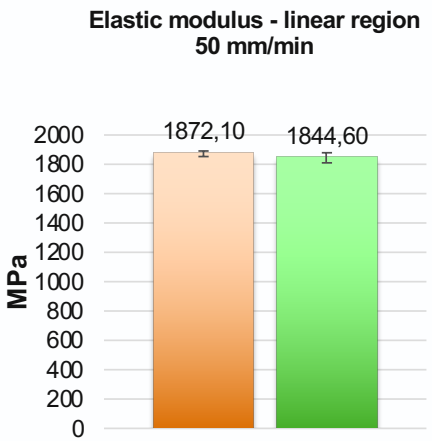
Name	Air/N_2	T rate (˚C)	T ign	Step 1		Step 2	
				Onset T (˚C)	%-wt. loss	Onset T (˚C)	%-wt. loss
BG834	N_2	30	526	311,5	5,4	440,6	77,7
BG857	N_2	30	523	317,5	5,0	443,2	80,2

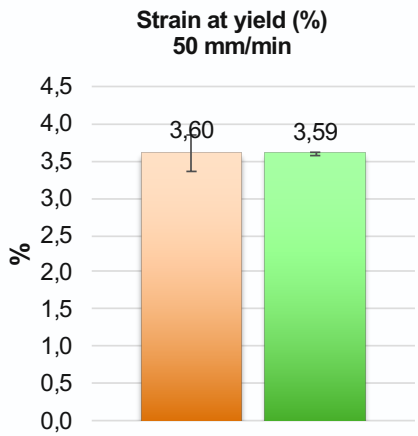


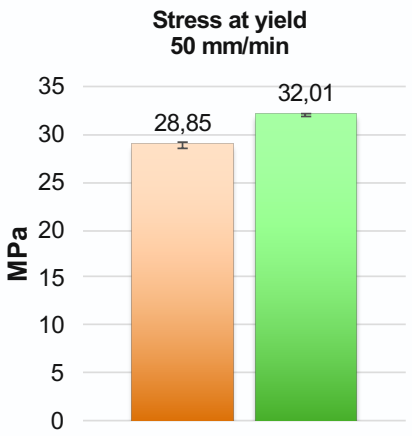
Lab: METTLER STAR° SW 9.10

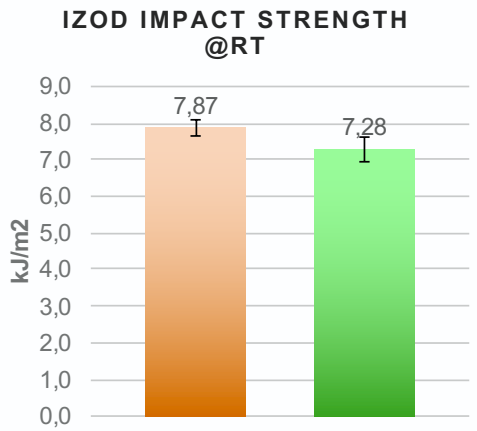
Paxymer

Periphnor EPFR110DM: Mechanical properties are retained compared to base case









Tensile testing: ISO527-3/1A/25. Izod impact tests: ISO 180-2001

BG834

BG857 (w Paxymer)

Paxymer

Everblend 1090: 4wt% reduction possible while maintaining UL94-V

Name	Formulation	UL94-V Rating (2mm)	MFI	Processing
BG902	30% Everblend 1090	V0	NA	
BG903	26% Everblend 1090 + 1% Paxymer BGMB62	V0	NA	

- P/N derivative based on non-APP + Synergist. Formulated system.
- Thermal stability: <250° C. Should be processed with gentle screw design and proper degassing/venting. P/N derivative will yield best results when side fed.
- The P/N derivative shows some tendency for bridging and proper feeding equipment should be utilized in order to ensure proper feeding.

Paxymer

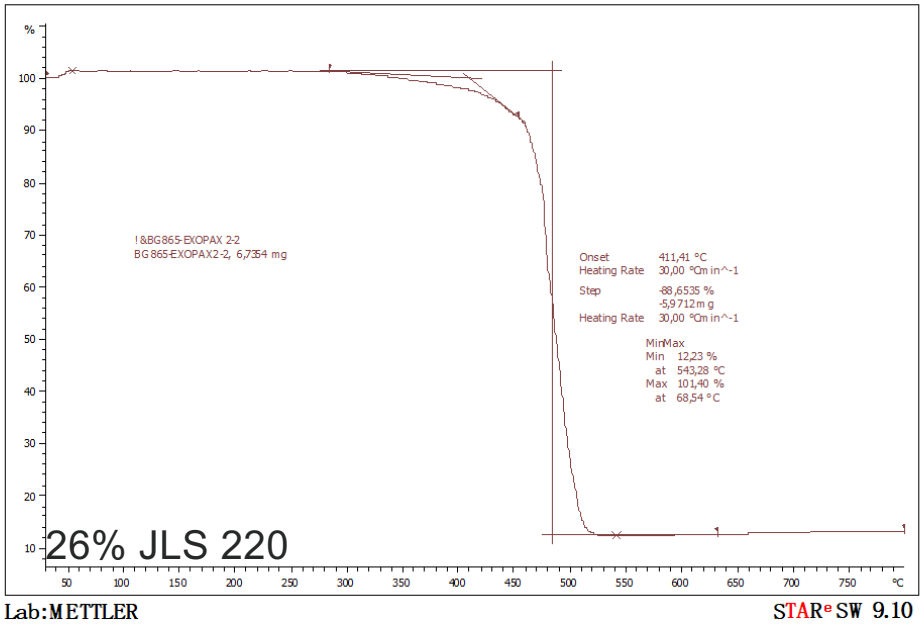
JLS PNA220: Potential to reduce FR content by 5wt% with retained UL94-V rating

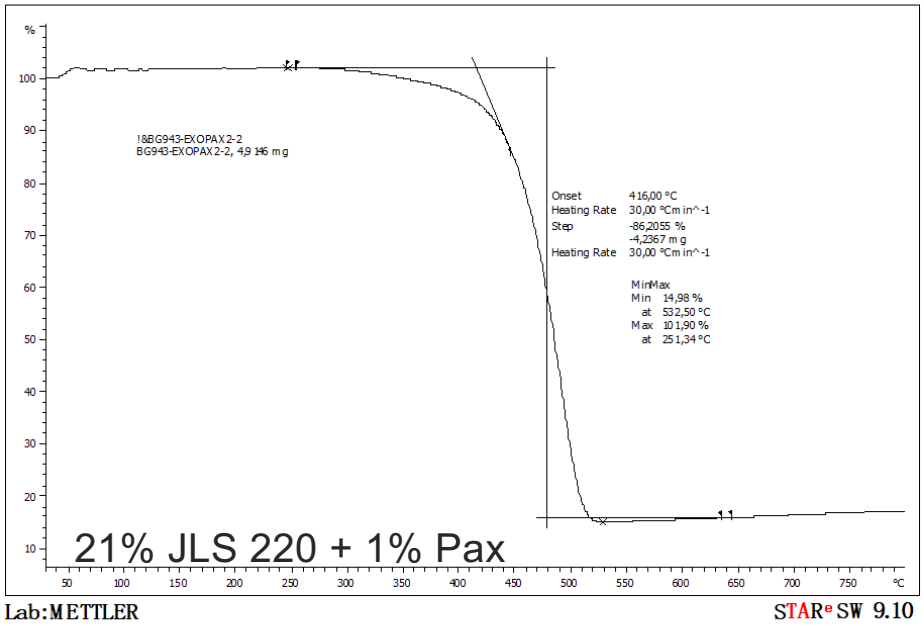
Name	Formulation	UL94-V Rating (2mm)	MFI	Processing
BG865	26% JLS PNA220	V0	5,7	Degassing / Feeding
BG943	21% JLS PNA220 + 1% Paxymer BGMB62	V0	5,9	

- P/N derivative based on non-APP + Synergist. Formulated system.
- Thermal stability: <250 degC. Should be processed with gentle screw design. P/N derivative will yield best results when side fed.
- The P/N derivative shows some tendency for bridging and proper feeding equipment should be utilized in order to ensure proper feeding.
- Venting / degassing is critical to obtain good quality of pellets and strands.
- **Potential cost savings: 0,24€/kg**

Paxymer

JLS PNA220: Improves ash residue even at lower level of FR.



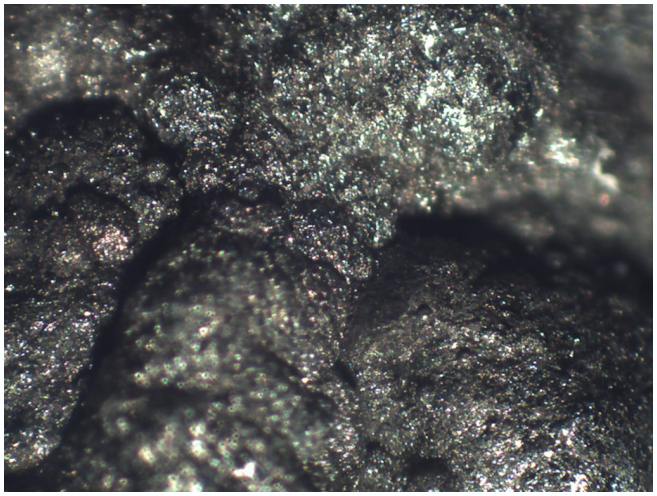


Name	Air/N_2	T rate (˚C)	T ign	Step 1		% Residue
				Onset T (˚C)	%-wt. loss	
BG867	N_2	30	491		88.3	12.2
BG943	N_2	30	510		86.6	15.0

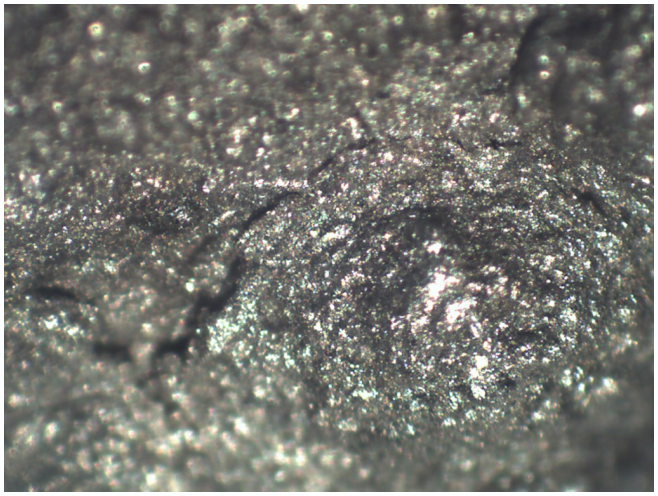
Paxymer

The addition of Paxymer to JLS PNA220 increases char formation and makes the char denser

Without Paxymer

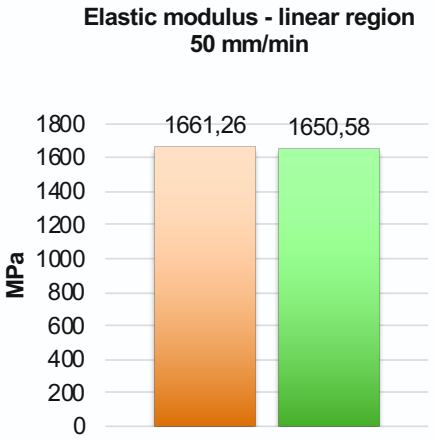


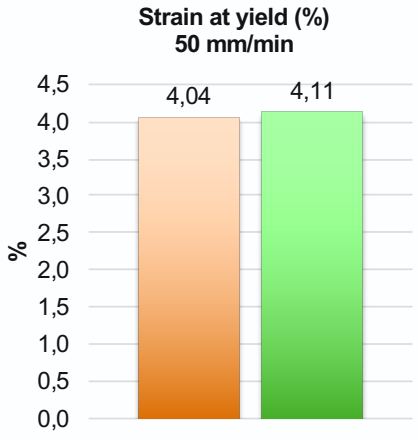
With Paxymer

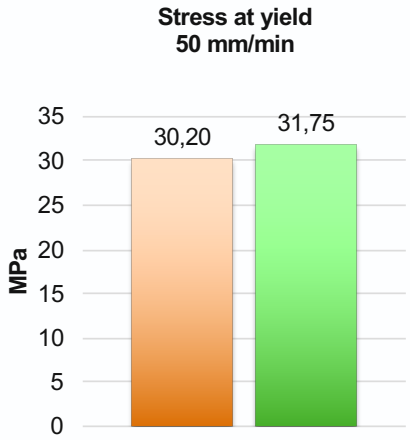


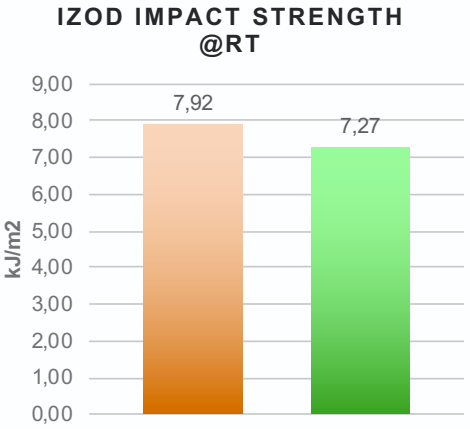
Paxymer

JLS PNA220: Mechanical properties are retained compared to base case









Tensile testing: ISO527-3/1A/25. Izod impact tests: ISO 180-2001

BG865 BG870 (w Paxymer)

Paxymer

Adeka FP-2500S: Potential to reduce FR content by 4wt% with retained UL94-V rating

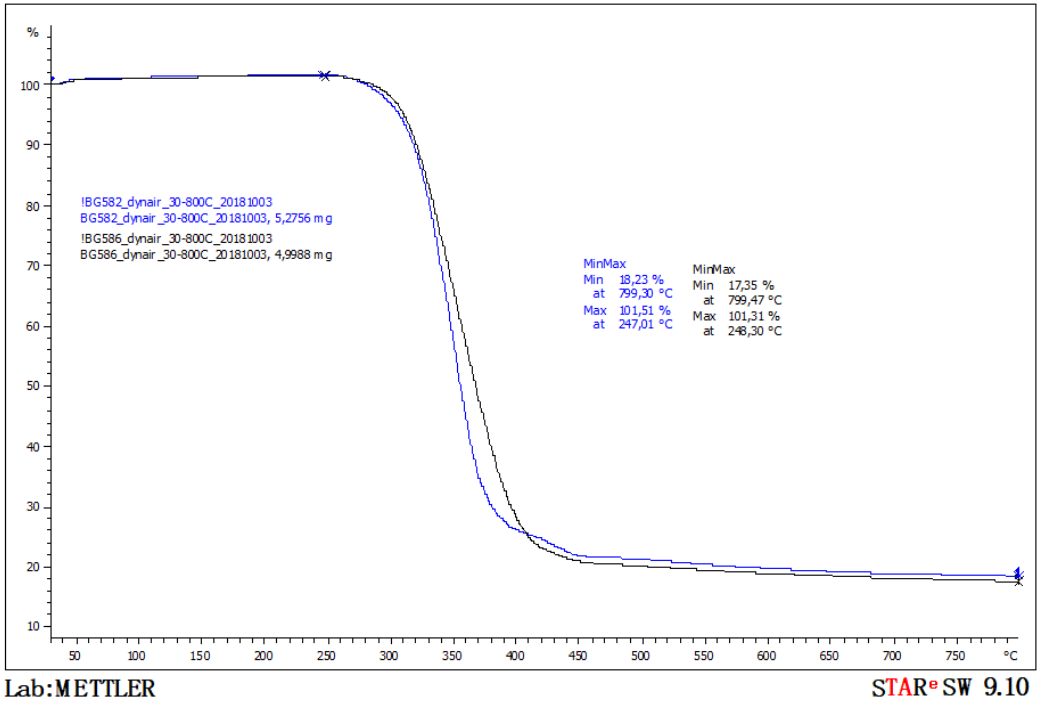
Name	Formulation	UL94-V Rating (2mm)	MFI	LOI (%)	Processing
BG582	28% Adeka FP-2500S	V0	7,0	41	
BG586	24% Adeka FP-2500S+ 1% Paxymer BGMB62	V0	7,4	37	

- Market leading non-APP formulated system and Paxymer BGMB62
- Thermal stability: <250 degC. Should be processed with gentle screw design and proper degassing/venting. P/N derivative will yield best results when side fed.
- Processing gave compact, smooth, non-soapy strands. Too much shear will have an adverse impact on fire results.
- LOI is retained even at significantly lower P/N content.
- **Potential cost savings: 0,21€/kg**

Paxymer

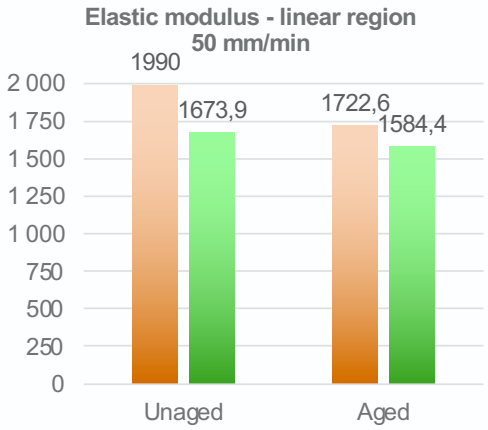
Adeka FP-2500S

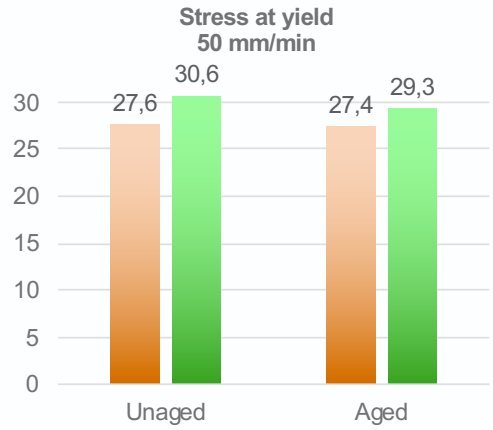
Name	Air/N_2	T rate (°C)	T ign	%Residue
BG582	N_2	30	548	18,2
BG586	N_2	30	512	17,4

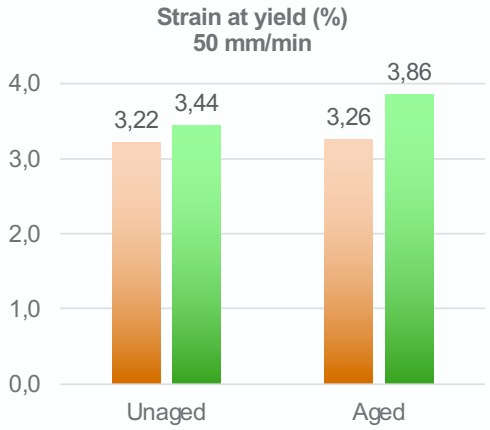


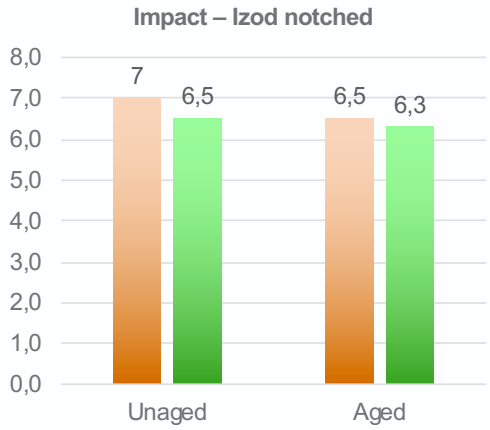
Paxymer

Adeka FP-2500S : Mechanical properties are retained compared to base case









Tensile testing: ISO527-3/1A/25. Izod impact tests: ISO 180-2001

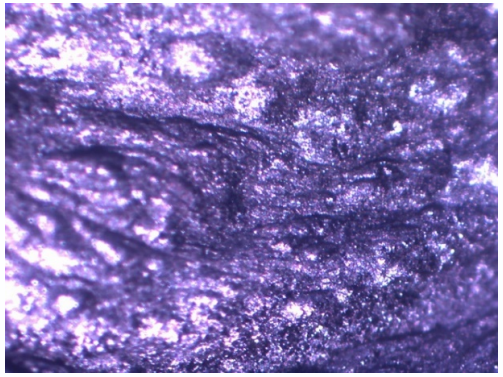
BG582

BG586 (w Paxymer)

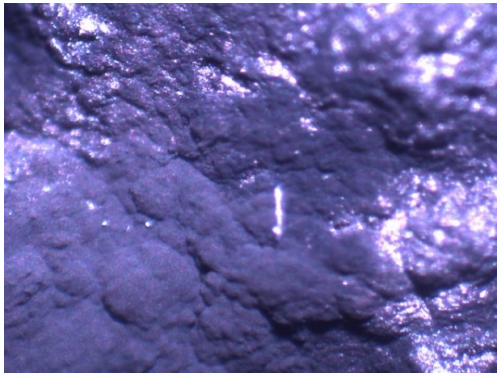
Paxymer

Adeka FP-2500S : Paxymer creates a more dense char formation and improve the barrier properties

Char formation of 28% OrgNP-4 (left) and 24% OrgNO-4 + 1% Paxymer BGMB62 (right) after burning.



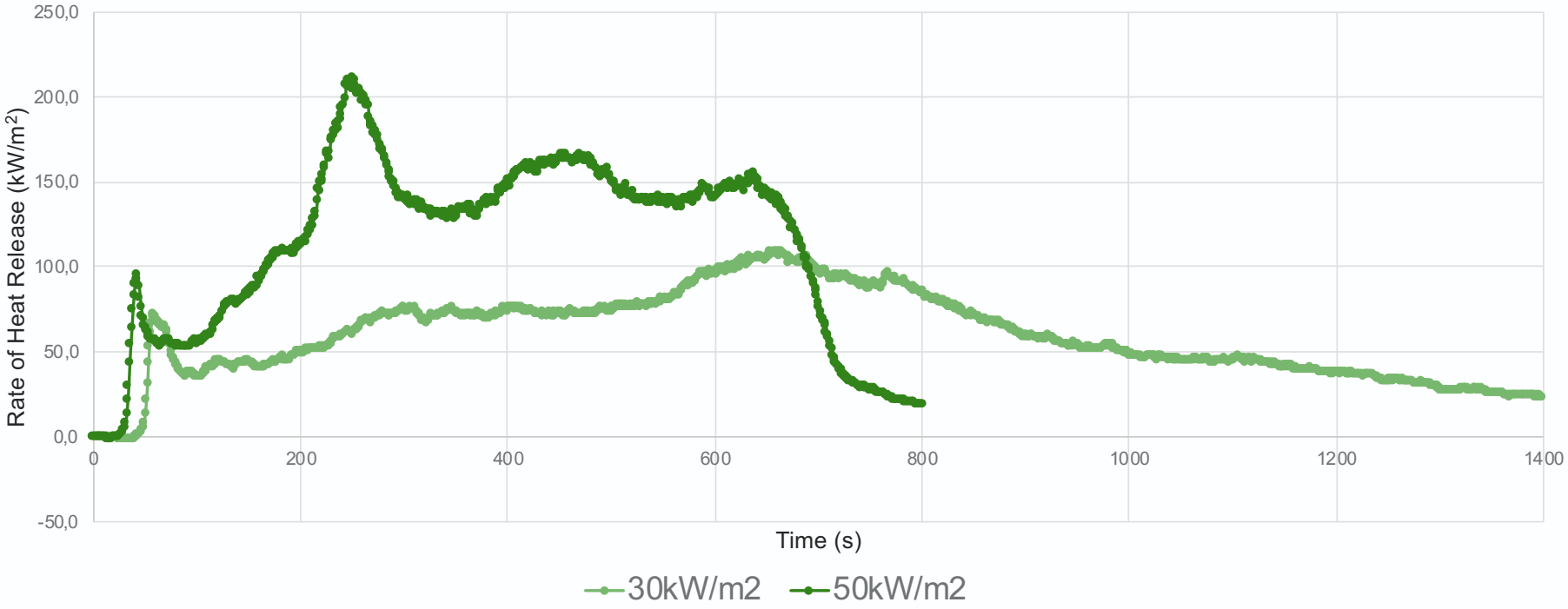
Char morphology of 28% OrgNP-4 after burning (x32 zoom)



Char morphology of 24% OrgNO-4 + 1% Paxymer BGMB62 after burning (x32 zoom)

Paxymer

Adeka FP-2500S : Cone Calorimetry comparison of HHR between 30kW/m^2 and 50kW/m^2 heat flux



Cone calorimetry testing: ISO 5660

Paxymer

Adeka FP-2500S: Cone Calorimetry comparative with and without Paxymer @ 50 kW/m^2

Name	24% OrgNP-4	24% OrgNP-4 + 1% Paxymer BGMB62
PHRR (kWm^{-2})	225	211,3
10min THRR (kWm^{-2})	66,1	122
MAHRE (kWm^{-2})	123	124,87

- Peak heat release rate is reduce and delayed.
- THRR is increased for 10 minutes. Both samples are fully combusted at the end of the test.
- MAHRE values are unchanged.

Paxymer

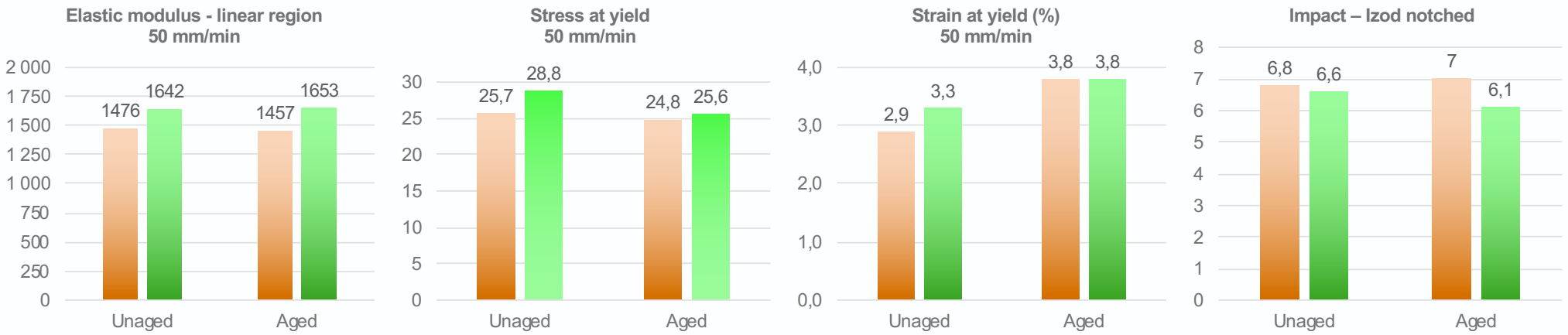
Adeka FP-2100JC: Potential to reduce FR content by 4wt% with retained UL94-V rating

Name	Formulation	UL94-V Rating (2mm)	MFI	LOI (%)	Processing
BG584	32% Adeka FP-2100JC	V0	6,4	38	
BG587	28% Adeka FP-2100JC + 1% Paxymer BGMB62	V0	6,3	29	

- One of the leading non-APP formulated systems and Paxymer BGMB62
- Thermal stability: <250 degC. Should be processed with gentle screw design and proper degassing/venting. P/N derivative will yield best results when side fed.
- Processing gave compact, smooth, non-soapy strands. Too much shear will have an adverse impact on fire results.

Paxymer

Adeka FP-2100JC: Mechanical properties are retained compared to base case. Aged samples retain properties equally well.



Tensile testing: ISO527-3/1A/25. Izod impact tests: ISO 180-2001

BG584

BG587 (w Paxymer)

Paxymer

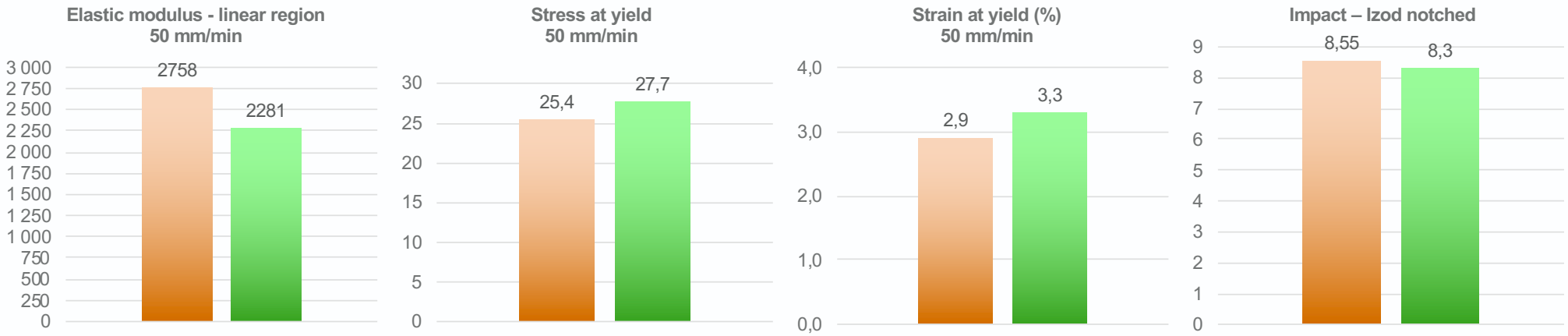
Lanxess Uniplex 44-94S: Potential to reduce FR content by 6wt% with retained UL94-V rating

Name	Formulation	UL94-V Rating (2mm)	MFI	LOI (%)	Processing
BG459	28% Uniplex 44-94S	V0	13,3	34	
BG450	22% Uniplex 44-94S + 2% Paxymer BGMB62	V0	11,8	30	

- Non-APP system and Paxymer BGMB62
- Thermal stability: <230 degC. Should be processed with gentle screw design and proper degassing/venting. P/N derivative will yield best results when side fed.
- Excellent for processing if shear can be controlled.
- **Potential cost savings: 0,28€/kg**

Paxymer

Lanxess Uniplex 44-94S:
Mechanical properties are retained compared to base case



Tensile testing: ISO527-3/1A/25. Izod impact tests: ISO 180-2001

BG459 BG450 (w Paxymer)

Paxymer