

Halogen-free Polyamides and Polyesters for Electronics

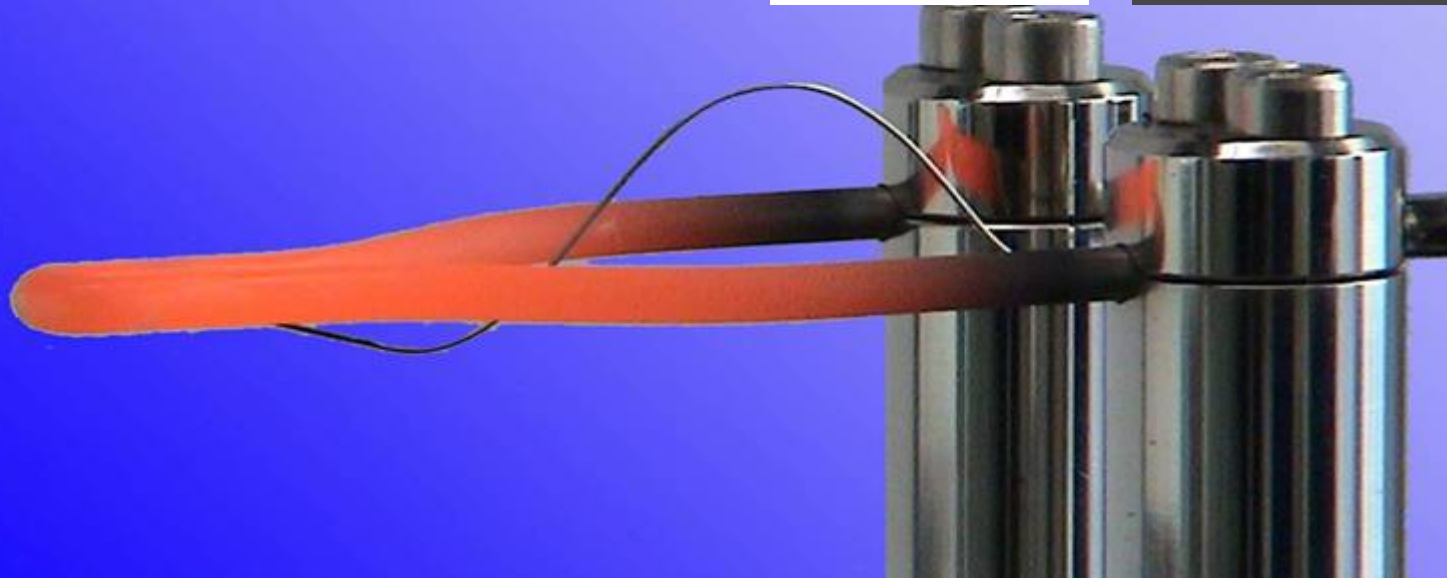
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EGG2008+ , Berlin, 09.09.2008



Exactly your chemistry.



Industry Trends

E & E trends



Impact on Polymers

- Miniaturization



Higher stiffness
Thinner walls

- Higher processing productivity



Improved flow

- RoHS directive



Lead free soldering
Phase-out of Deca

- WEEE separation and recycling



Halogen-free flame retardants

Flame Retarded Polymers for E&E

- Safety requirements are increasing steadily
- UL 94 and IEC 60335 (GWIT) are the most important tests
- Different flame retardants can be used
 - Bromine-, Hydroxide-, Nitrogen-, and Phosphorus-FRs
- Increasing demand for halogen free solutions due to legislative actions (WEEE, RoHS) and internal policy of many OEMs





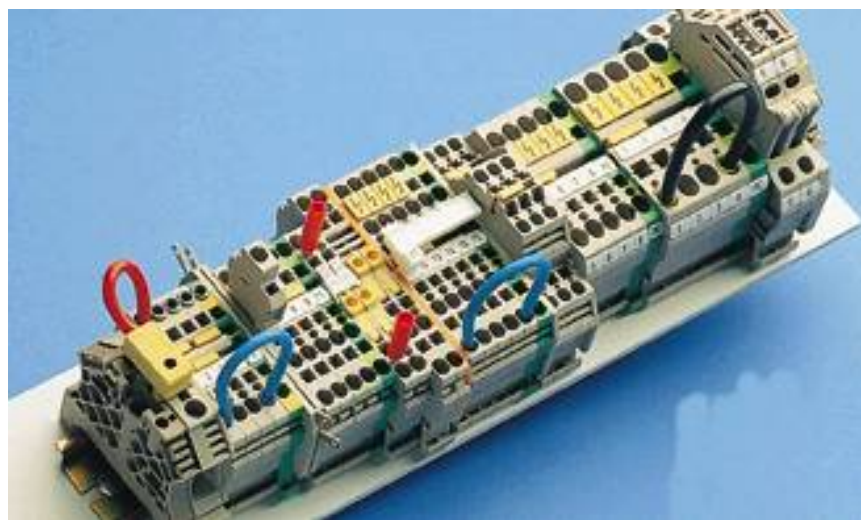
FR Systems for Polyamide 6 and 66

**Halogen-free Polyamides
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Flame Retardants for PA 6 & 66 E & E industry

Halogen-free Flame Retardant types available

- Magnesium hydroxide: PA 6 reinforced
- Melamine cyanurate: PA 6 & 66 non-reinforced
- Metal phosphinates + Melamine polyphosphate: PA 6 & 66 reinforced
- Red phosphorus: PA 66 reinforced

Eco Profile of Phosphinates

Status

- The environmental behavior of metal phosphinates is characterized by:
 - the flame retardant itself is non-toxic, does not bioaccumulate
 - no release of volatiles from finished products
 - lower smoke toxicity in case of accidental fire compared to brominated flame retardants
 - end of life: suitable for recycling, no problems in waste incineration



Fraunhofer

Institut
Umwelt-, Sicherheits-,
Energietechnik UMSICHT



Eco Profile of Melamine based FRs

Status

- The environmental behavior of melamine cyanurate (MC) and melamine polyphosphate (MPP) is characterized by:
 - the flame retardant itself is non-toxic
 - low smoke toxicity, density and corrosivity
 - no release of volatiles from finished products
 - less corrosive to processing equipment

- Regulatory compatibility
 - Meets OEM requirements for halogen, antimony and heavy-metal free FRs
 - Allows finished products to conform to eco-label criteria and recyclability regulations

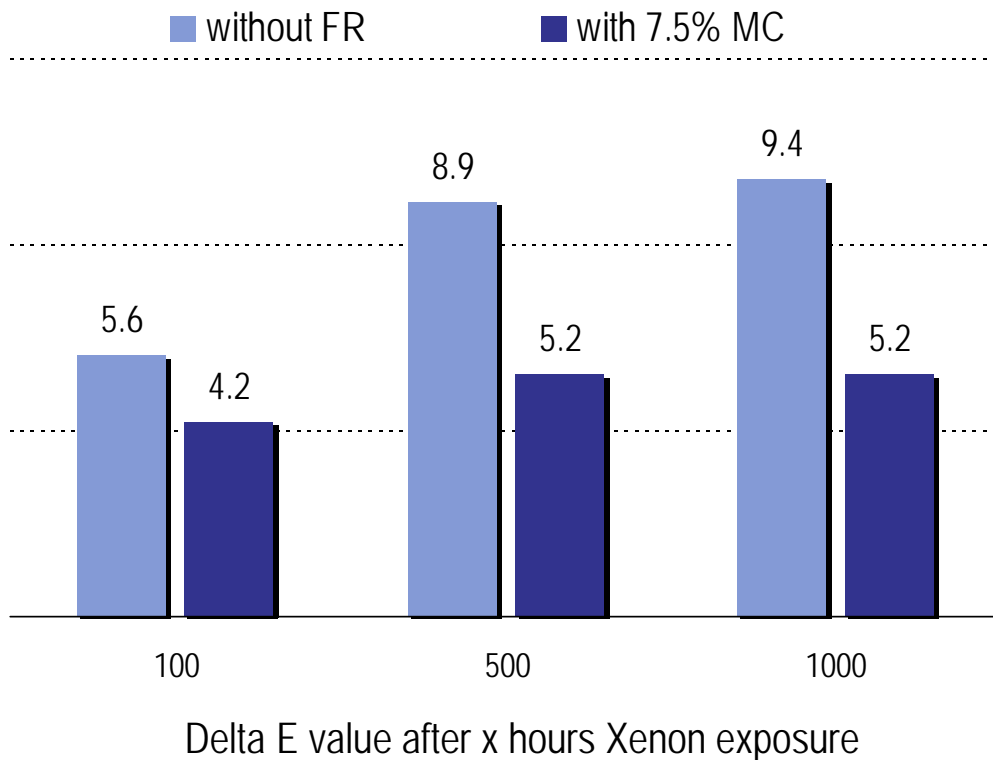


Characteristics of Polyamide 6 and 66 compounds with different FRs

	MC	Phosphinates	Red Phosphorus	Mg (OH) ₂	Br PS
electrical properties	+	+	+	+	-
mechanical properties	+	+	+	-	+
colorability	+	+	-	+	+
processing	0	+	0	0	+
total recipe cost	+	0	0	+	0
image	+	+	0	+	-
range of applications	0	+	0	-	+
recyclability	+	+	0	?	+
smoke	0	0	0	0	-

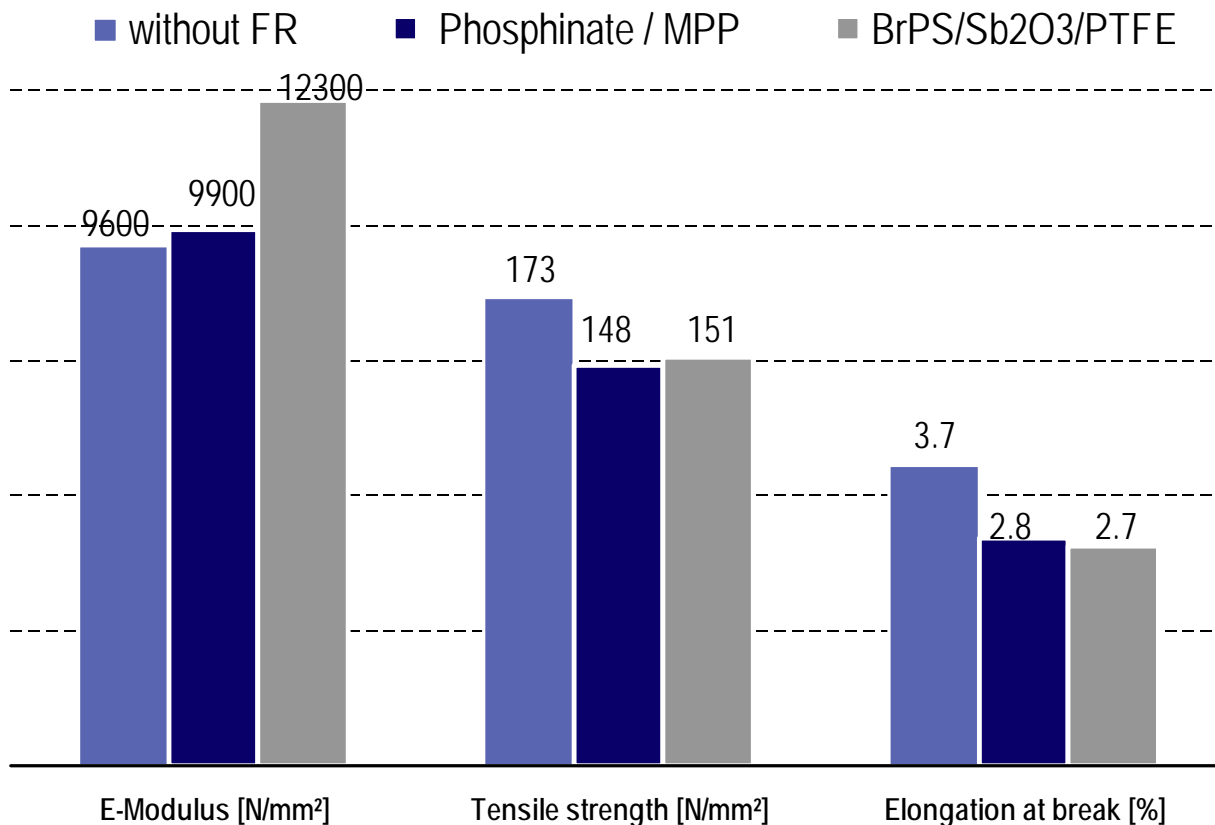


Halogen-free Polyamide 66 unreinforced with Melamine cyanurate based FRs - MC contributes to UV protection



Good color retention while maintaining mechanical properties and flame retardancy (UL94 V-0)

Halogen-free PA 66-GF30 with MPP & phosphinate based FRs - Mechanical properties



Good mechanical properties while maintaining flame retardancy (UL94 V-0)

Polyamide 6 & 66 conclusion

- A variety of good flame retardants are available on the market.
- You have to carefully choose the one that fits to your specific application
- No existing FR offers the "one fits all" solution

Halogen-free solutions:



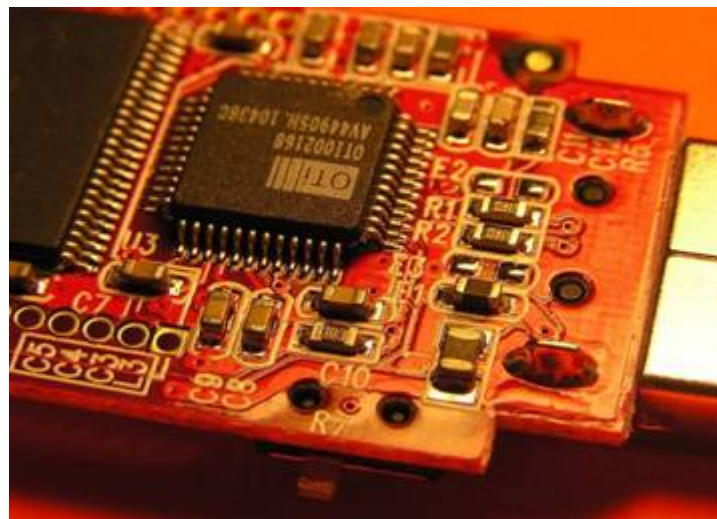
- All types mentioned are commercially available, already used in large amounts and have proven their strengths.
- They are mostly comparable or even favorable in total recipe costs compared to halogenated systems.



FR Systems for High Performance Polyamides

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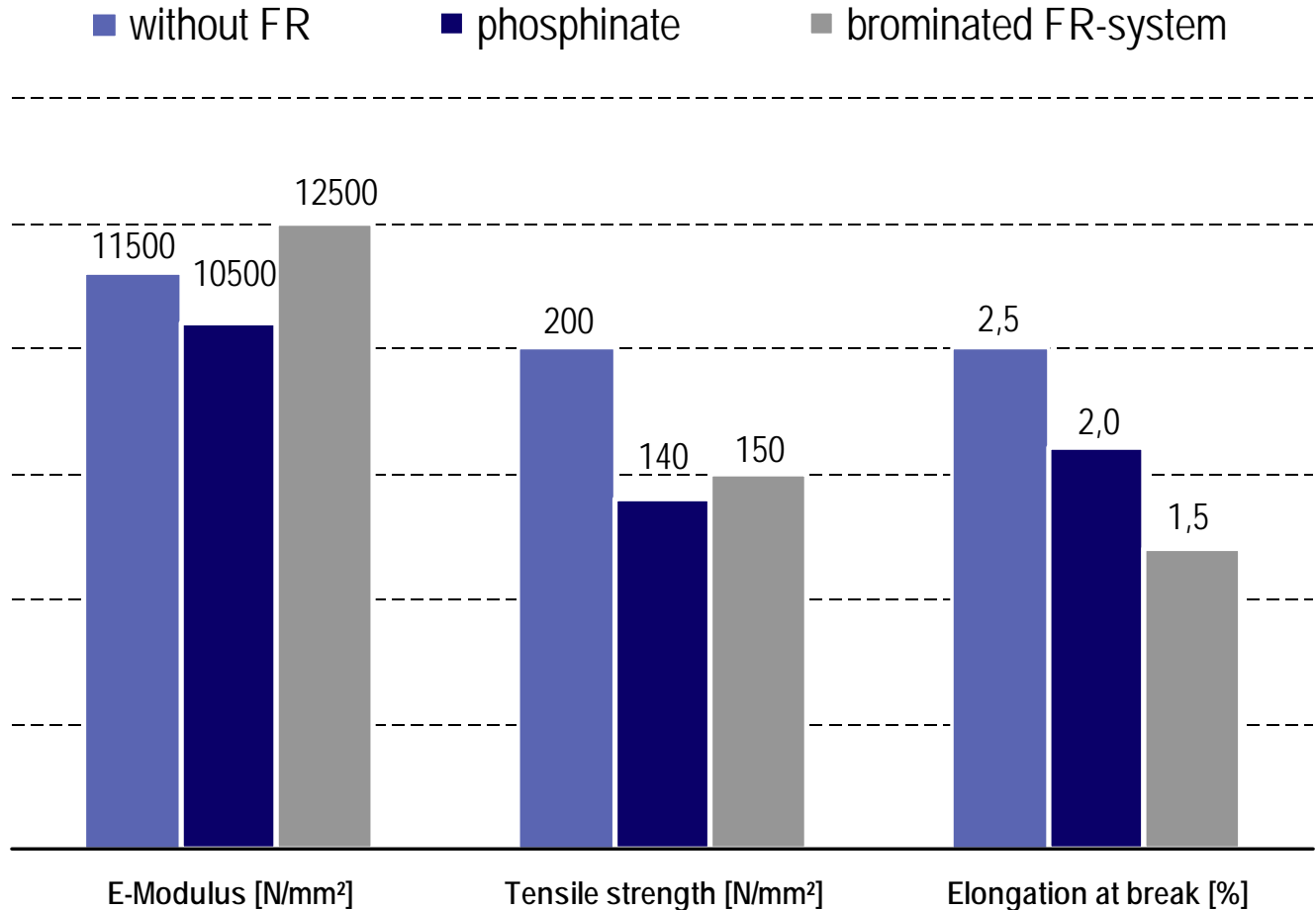
Flame Retardants for HPPAs for E & E industry

Halogen-free Flame Retardant types available

- Metal phosphinates: commercially available compounds of almost all types of HPPAs are one the market

Mechanical properties of PA 6T/66-GF30

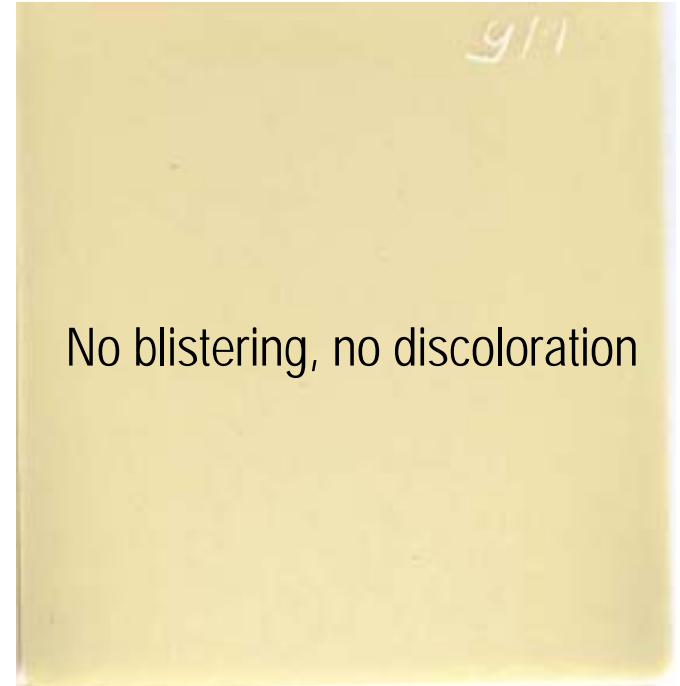
- Halogen-free compound gives better elongation, higher CTI and lower density



Lead-free Soldering of PA 6T/66-GF30

■ PA 6T/66 GF30

with Exolit OP



- Storage: JEDEC-J-Std 020C (MSL 2) 85 °C/60% rel. humidity
- Reflow oven 260 °C peak temperature



Halogen free - High performance Polyamides

Characteristics:

- UL 94 V0 down to 0,35 mm
- good flow
- stable for lead free soldering
- excellent electrical properties
- high weld line strength
- no blistering tendency
- cost savings versus high performance polymers (LCP, PES)



Halogen free - High performance Polyamides

Conclusion:

- A number of halogen-free compound grades are already available. Additional materials will be launched in 2008/2009.
- Phosphinate based HPPAs outperform existing halogenated systems

Recommendation :

- Wear resistant processing equipment



FR Systems for Polyesters

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Polyesters in E & E industry (choosing the right FR)

- High processing temperatures (250 - 300 °C)

- Polyesters are sensitive against certain additives
 - polymer degradation
 - loss of mechanical properties

- Many applications require high permanent use temperatures of 140 °C

- Crystallinity leads to tendency of blooming of FR

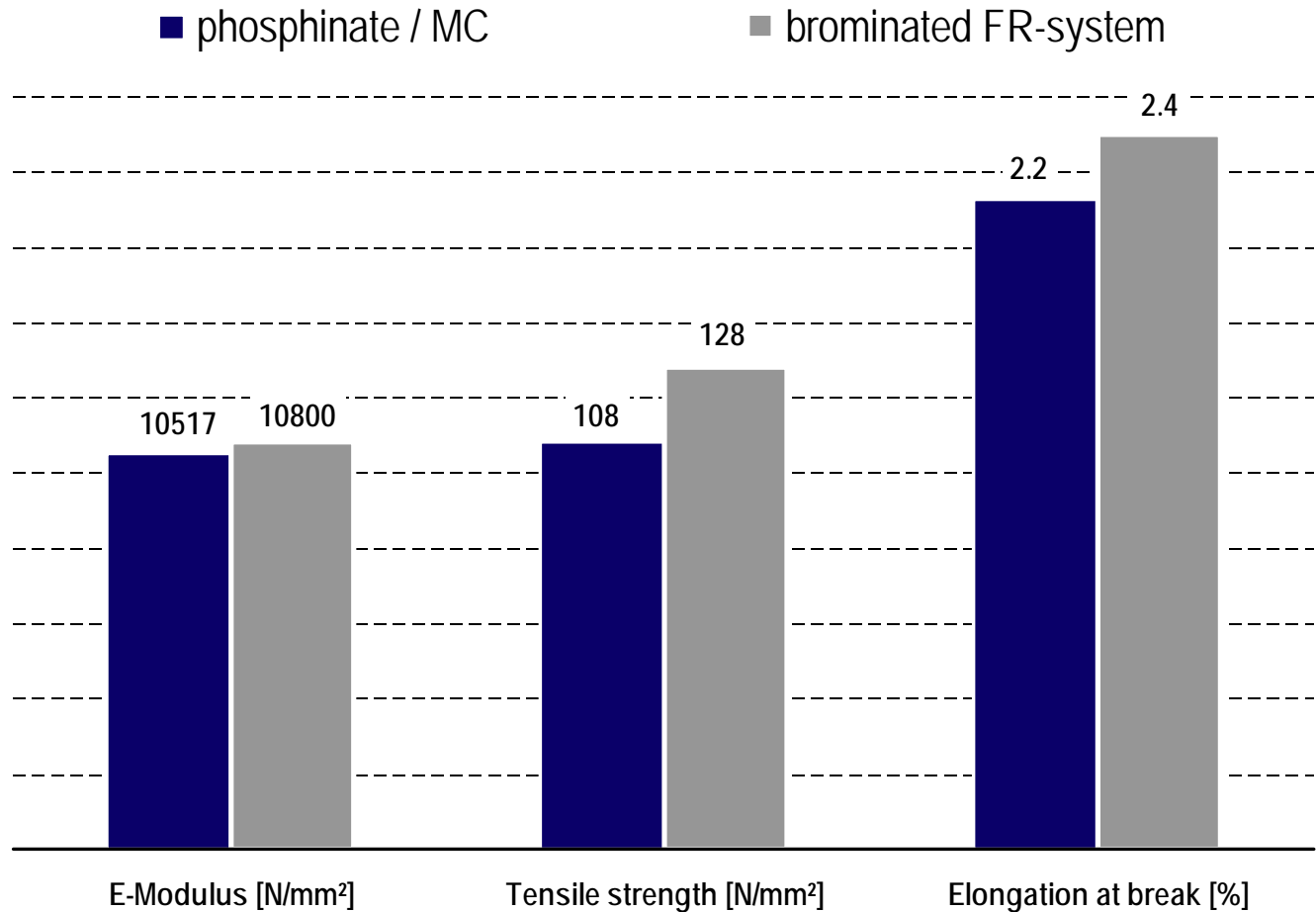
Flame Retardants for PBT and PET E & E industry

Halogen-free Flame Retardant types available

- Melamine cyanurate + Metal phosphinates : PBT all grades
- Melamine polyphosphate + Metal phosphinates : PBT all grades
- Metal phosphinates : PBT & PET all grades
- Red phosphorus: niche applications

Halogen-free PBT-GR V-0 Formulations

Physical Properties – Tensile Test (ISO 527)

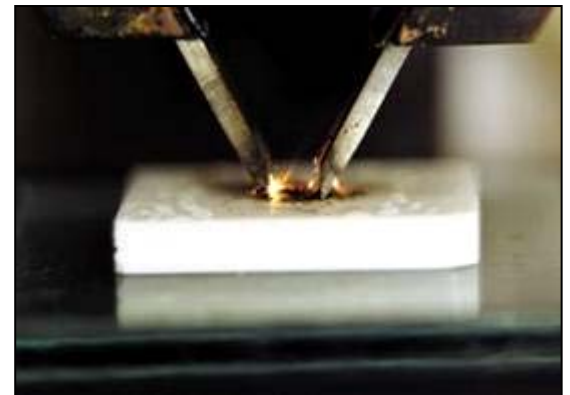




PBT-GR V-0 with a combination of Phosphinate and Melamine based FRs

Characteristics

- non-halogenated
- UL 94 V0 down to 0,8 mm
- high CTI (500-600 V)
- balanced mechanical properties
- low density of compounds
- good light resistance
- all colors



PBT-GR V-0 with a combination of Phosphinate and Melamine based FRs

Conclusion:

- Halogen-free compounds offered for 1 – 2 years are a convincing alternative to the existing brominated ones.
- Mechanical properties are not on the benchmark level, but high enough for most applications.
- The number of compound producers for that technology will grow during the next months / years.



FR Systems for TPEs

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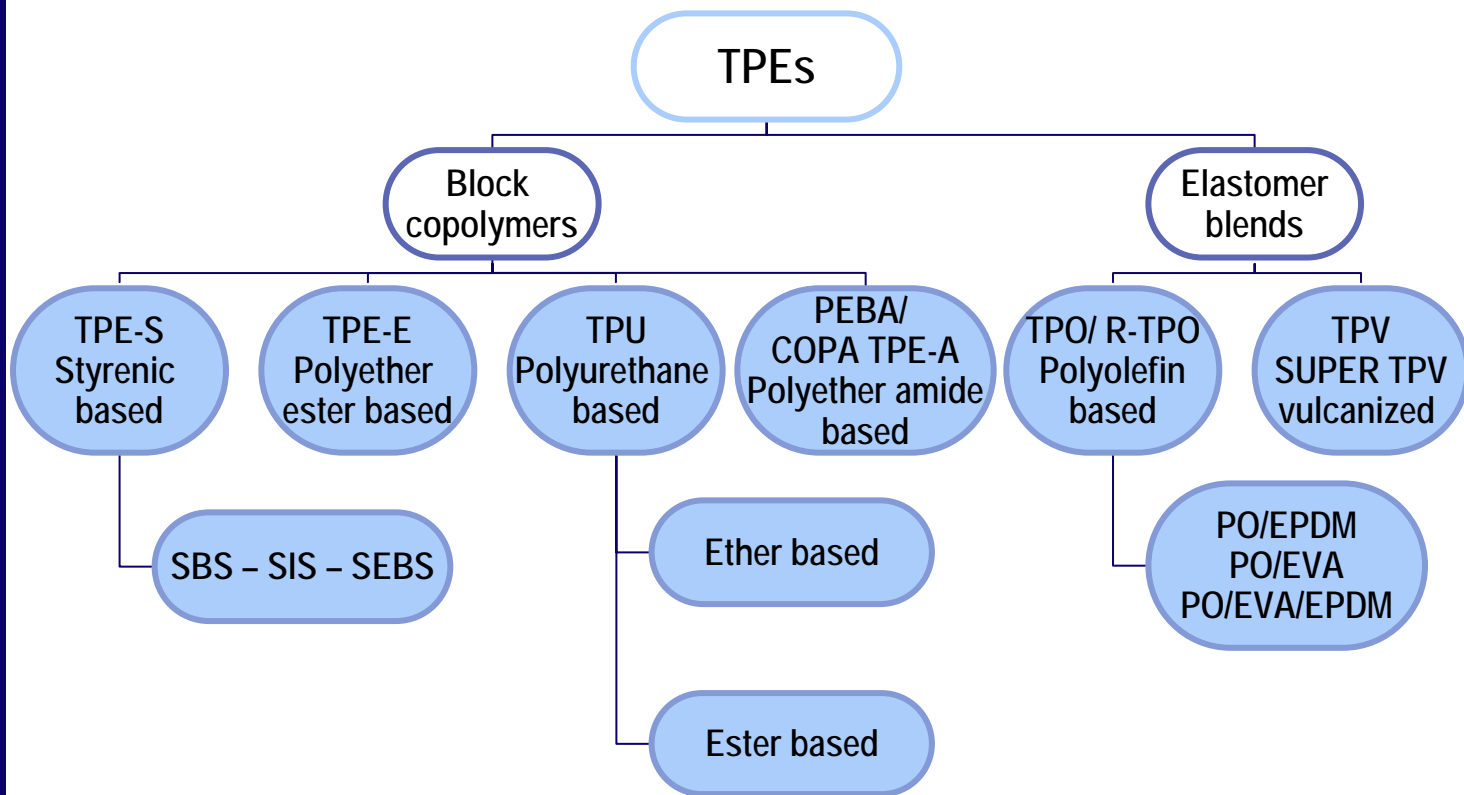
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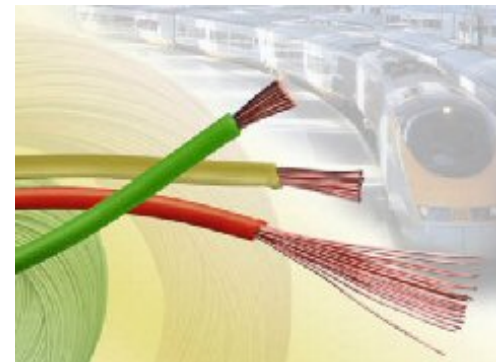


The TPEs' Family Tree



Halogen-free TPEs

- Cables sheathing and wiring are the main applications for flame-retarded TPEs
- Several halogen-free solutions of different chemical nature (Melamine cyanurate, Metal phosphinate, Aluminium hydroxide) are available for this heterogeneous group of polymers
- There is an increase of activities on that market due to the PVC replacement by several OEMS





Summary



Halogen-free Flame retarded plastics for the (E & E) industry

- For PA 6 & 66, HPPA, Polyesters, PPE/HIPS, PC and blends like PC / ABS and TPEs, there are technically and commercially attractive halogen free solutions available.
- Same is true for most Polyolefins and PO - blends.
- In addition, a variety of halogen-free PWBs (rigid and flexible) are in the market already .
- Open issues are ABS and PSresearch activities ongoing
- Completely halogen-free assemblies are possible

Thank you!

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**Any questions? Visit us at the joint KIT- industry booth
or check our websites:**

www.exolit.com

www.melapur.com

www.flameretardants-online.com



Exactly your chemistry.



End