

New Class of Nitrogen and Phosphorus Based Flame Retardants for Engineering Plastics

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**FIRE RESISTANCE
IN PLASTICS
2010**

Content

- Safire® product profile
- How they work
- Application in PA
- Summary

CATENA Additives

- Part of FLORIDIENNE Group
- Specialise in development and manufacture of customer- and application- specific additives for polymers
- Member of 

Core Product Lines

PVC-Stabilisers

Flame Retardants



Safire[®] Flame Retardants Chemistry : N- and P-containing Organic-Inorganic Polymeric Hybrid Materials

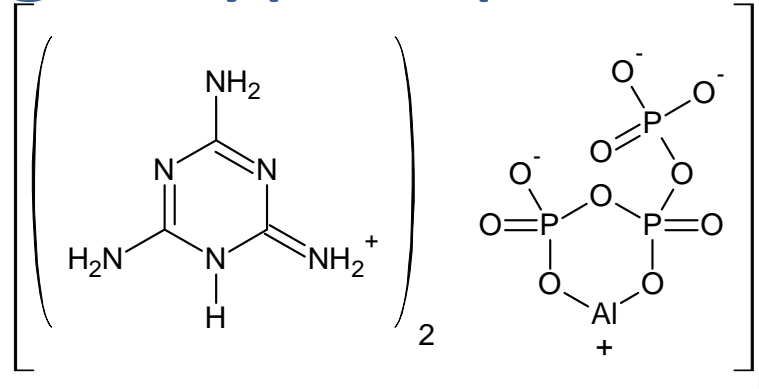
Safire[®] 200: Melamine-poly(aluminium phosphate)

Safire[®] 400: Melamine-poly(zinc phosphate)

Source of N- and P- with Metal Forming Polyphosphates

Safire® 200

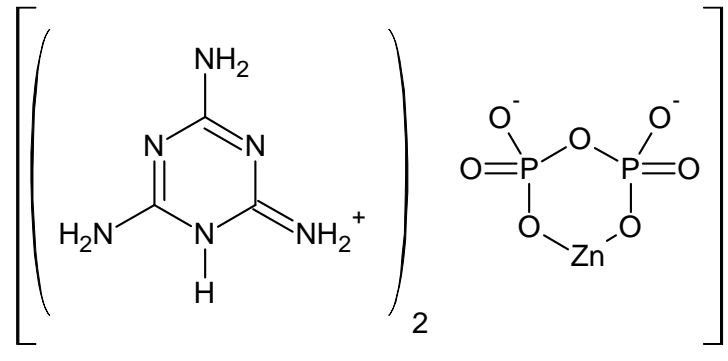
Melamine-poly(aluminium phosphate)



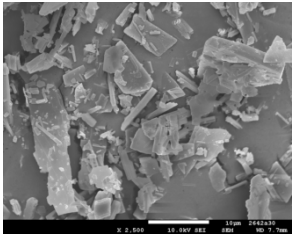
N: 31-32 %
P: 17-18 %
Al: 5-6 %

Safire® 400

Melamine-poly(zinc phosphate)



N: 34-35 %
P: 12-13 %
Zn: 13-14%



Safire[®]: Physical Properties

- Halogen-free
- White fine powder
- Available in different particle size (1-2 μm , 10-12 μm)
- Patented technology

	Bulk density g/ml (range for diff. part. Size)	pH (10 % suspension in water)	Surface area (BET) m ² /g
Safire [®] 200	0.10 to 0.13	4.3 - 4.5	8.5 – 9.9
Safire [®] 400	0.35 to 0.36	5.0 - 5.5	2.2



Safire[®] 200 and 400:

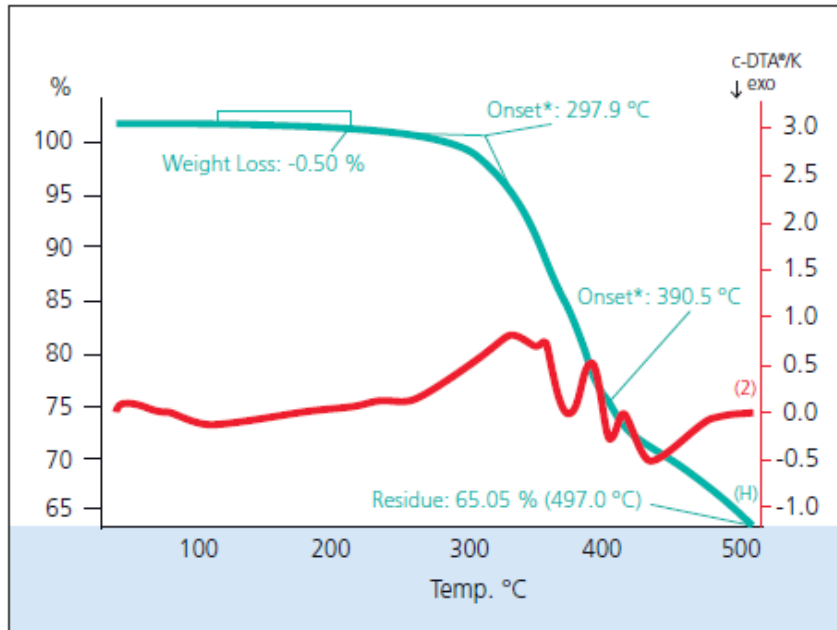


Toxicological Data

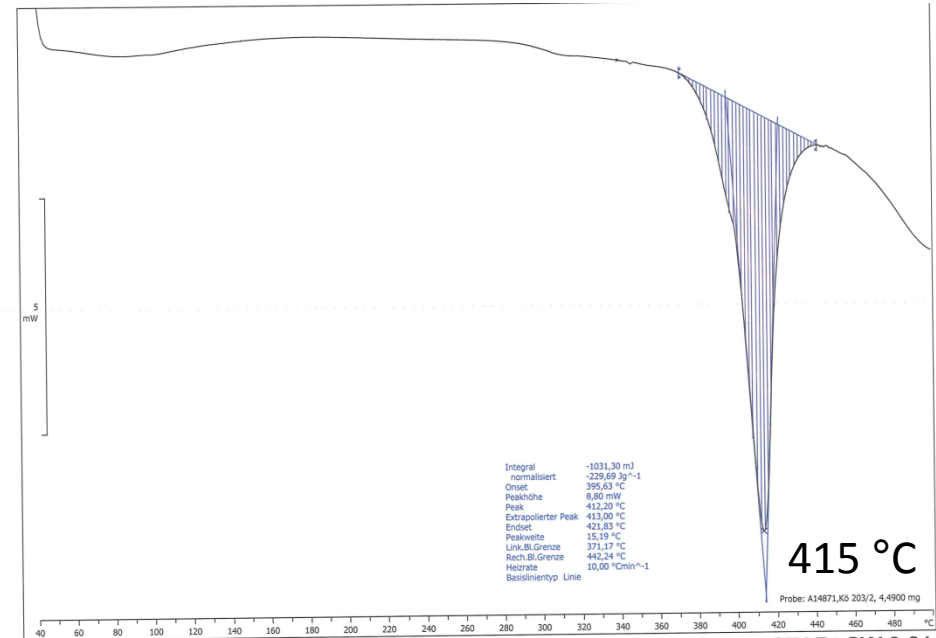
- Very low solubility in water (< 0.05 g/L)
- Insoluble in organic solvents
- Both Safire[®] grades do not need any labeling
- Oral toxicity: LD50 > 2000 mg/kg body wt.
- Sensitization: Non irritant
(human skin model & LLNA)

Thermal Stability

Safire® 200



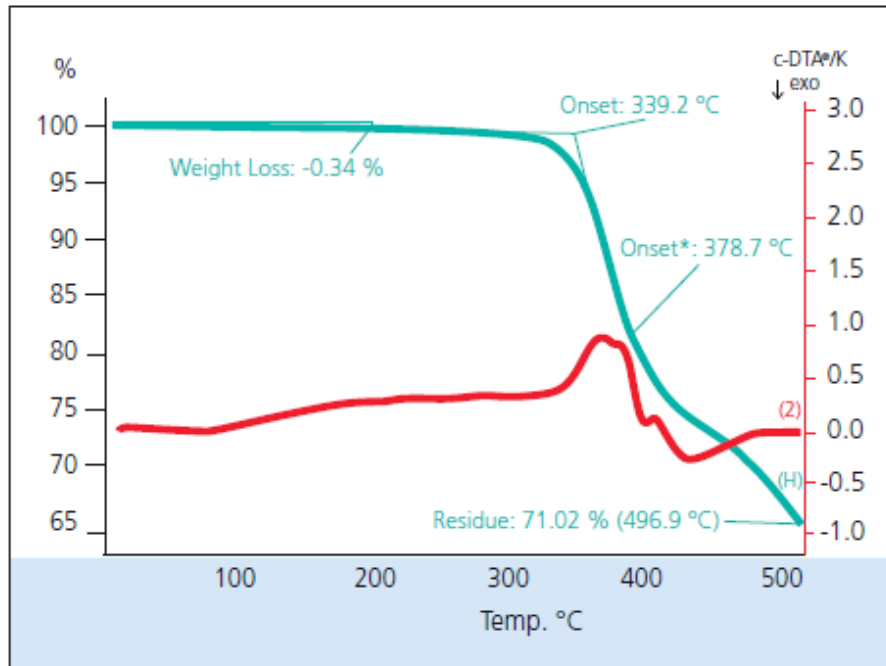
TGA



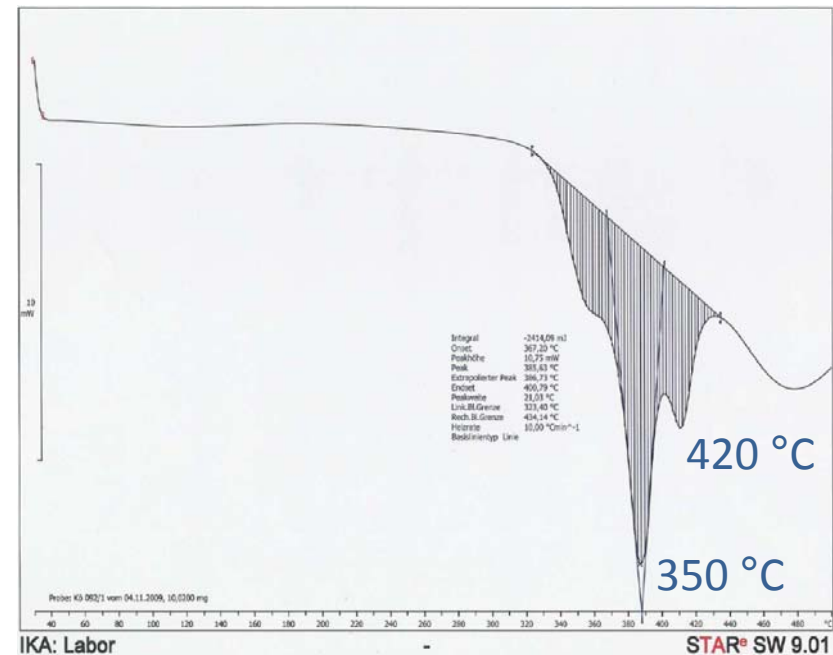
DSC

Thermal Stability

Safire® 400



TGA



DSC

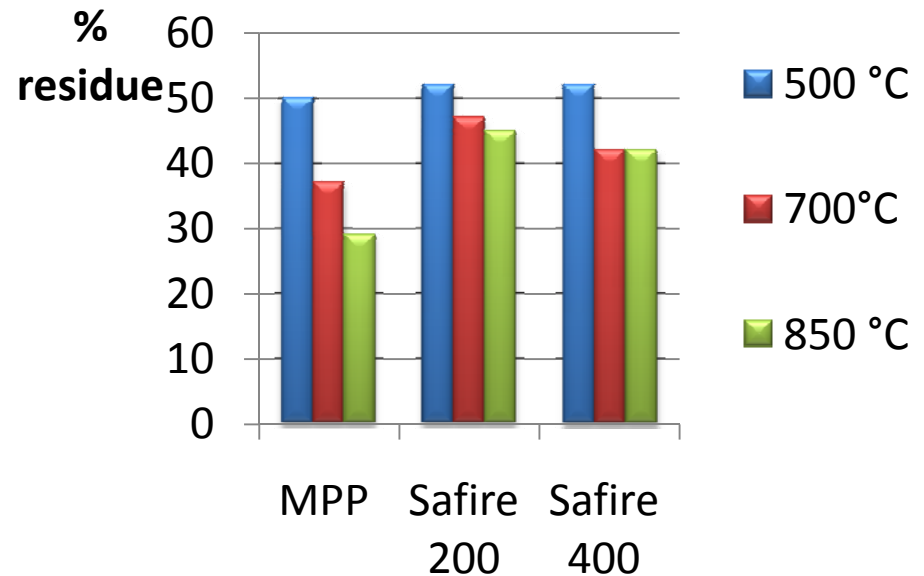
How Safire® Products Work as Flame Retardants



- Char formation
- Heat sink
- Intumescent / foaming agent
- Synergism with metal hydroxides
- Synergism with metal phosphinates

Safire Flame Retardants have lower volatiles (higher residues) resulting from the glassy barrier

	500 °C (residue in %)	700°C (residue in %)	850 °C (residue in %)
MPP	50	37	29
Safire 200	52	47	45
Safire 400	52	42	42



Performance of Safire®
Polymer Examples:
PA (GF)
PE (Cable)

PA: Formulations Compared

F1

**Competitive system (2 components)
Phosphinate + MPP**

F2

**Competitive system (3 components)
Phosphinate + MPP + ZB**

F3

**Safire[®] system (2 components)
Phosphinate + Safire[®] 400**



Limited Oxygen Index: PA 6.0 (25GF) V0 Formulation with 18 % Loading for 0.8mm

LOI-Samples: 6.5 x 3.0 x 150mm

	Phosphinate [%]	MPP [%]	ZB [%]	Safire® 400 [%]	LOI/ % O ₂	UL94 ranking
F1	12	6	-	-	26	V0
F2	11	5	2	-	30	V0
F3	12	-	-	6	34	V0

UL 94 Test

PA 6.6 (GF30) Formulation with 15% Loading

Samples: 125 x 13 x 1.6mm

Formulation: Phosphinate [10%] +	Flame time after first ignition [sec]	Total flame time [sec]	UL94
MPP [5%]	19	55	V1
Safire® 200 [5%]	18	46	V0
Safire® 400 [5%]	8	33	V0

Samples After 2 x 10 sec. Burnings

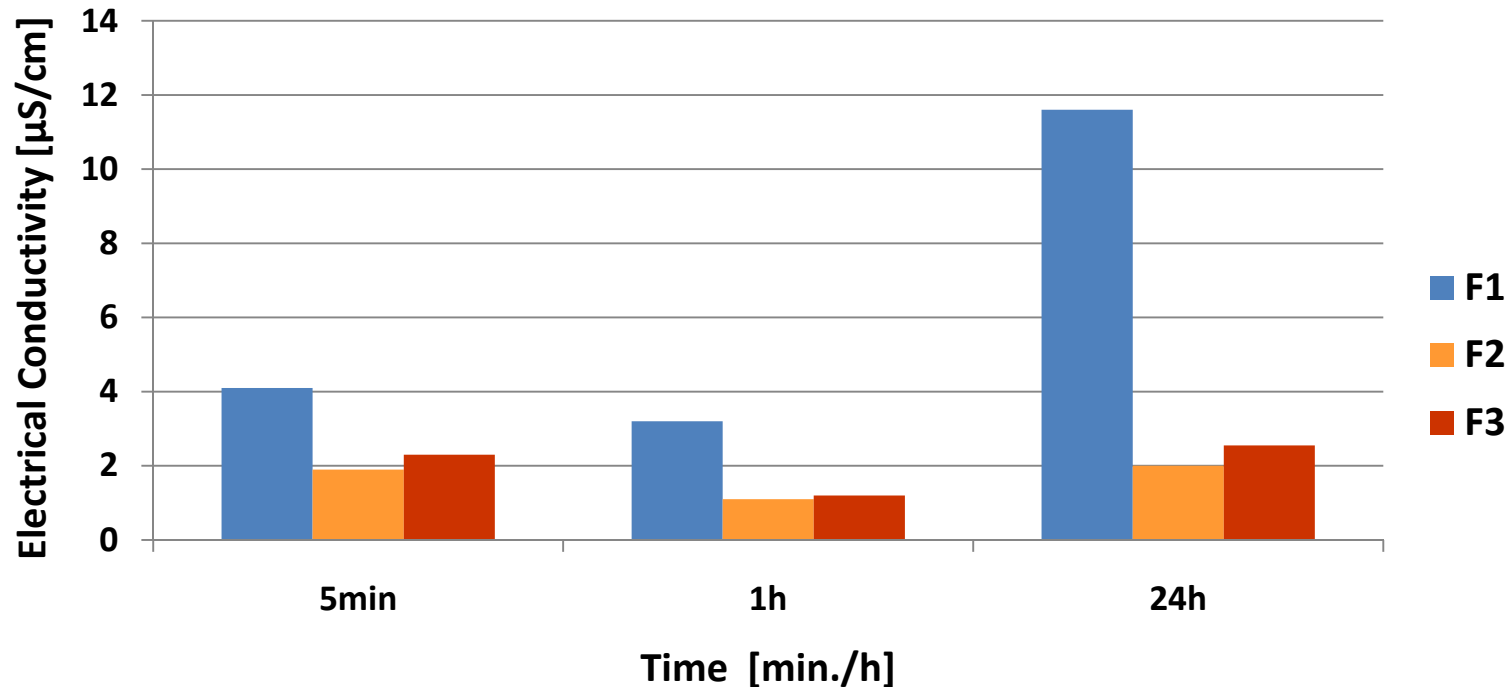


0.8 mm



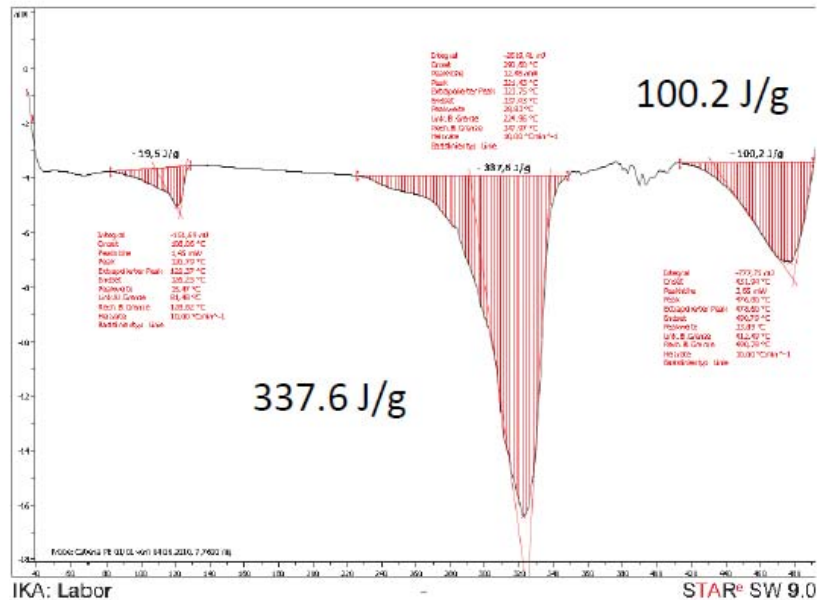
1.6 mm

Water Resistance/Leaching Safire[®] in Comparison to MPP

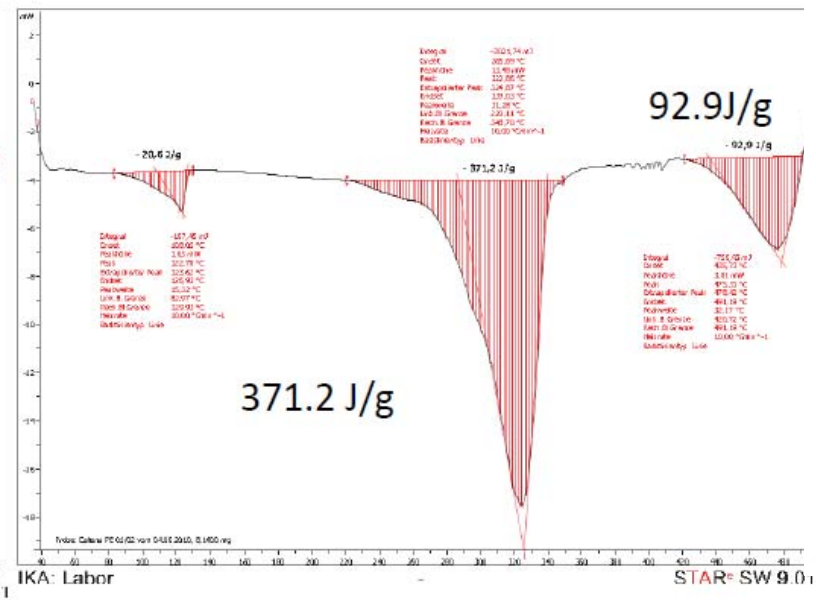


Samples were stored for 24h at 70 °C, 95% RH
 Samples were dispersed in deionized water
 and Conductivity was measured

Further Applications: PE Cable Compounds



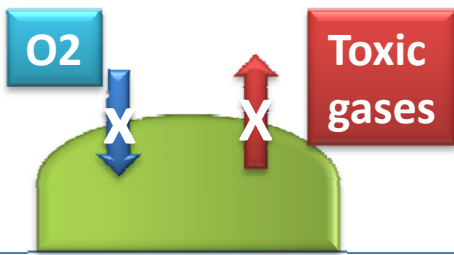
DSC: 65% ATH



DSC: ATH 38.5%
Safire 200 7.7%

Flame Retardants Work

- Form glass (metaphosphates) on the burning surface
- Safire[®] 200 gives Aluminium metaphosphate (ca. 50%)
and
Safire[®] 400 gives Zinc metaphosphate (ca. 45%)
- MPP gives vP_2O_5 -glass (ca. 30%); known to be hygroscopic
- It is well known that Aluminium phosphate glass improves resistance to water vapours
- MC gives no glass (no residue)



Summary

- Safire flame retardants promote char forming and smoke reduction
- Enhance heat sink through formation of glassy barrier layer
- Avoid diffusion of toxic gases from polymer
(cone calorimeter data available for PVC yet, others are in progress)
- Avoid entering of O₂
- No Zinc borate as stabiliser/co-component required

Safire® Availability

Current capacity: pilot plant

New plant: under planning;
ready by mid 2012



Outlook



- Results very promising
- Very positive customer feedback
- Further investigations in progress
- Registration: EU, JP, US, Korea under progress
- Formulations in other substrates; FR testing laboratory in progress

Thank you for your attention