The Clear Choice for Flame Retardant Plastics
“The Future is Plastics”

The Graduate (1967) with Dustin Hoffman:

“There's a great future in plastics. Think about it. Will you think about it?”

Early plastics (back in the middle ages!) were bio-derived materials (animal and vegetable proteins). Today, the majority of the plastics are oil-based but there's a trend back to bio-derived materials (e.g. PLA)

2015: ~300MM TPA

1967: ~25MM TPA

AAGR ~5%
~5% of all Plastics contain Flame Retardants

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<th>Electrical Equipment and Consumer Electronics (EE&amp;CE)</th>
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Average Annual Growth Rate of Flame Retardants ~6 - 7%
Why Flame Retardants?

- Wikipedia: “materials used in plastics to inhibit or resist the spread of fire”
- 2 – 2.5 million fires each year in Europe
- In 2007, about 3,000 fire fatalities in EU, 4,000 in USA, and 2,000 in Japan.
- At least 90% of these fire deaths occurred in homes and buildings
- Direct and indirect costs of fires ~ 1% of GDP in developed world
- Today, homeowners would have less than 3 min to get out of a burning house compared to 17 min in the 1970’s
A Revolution is Taking Place!

Bromine containing Flame Retardants:

- Persistent
- Bio Accumulates
- Toxic in animal tests
- Continuous pressure from NGOs on OEMs

- 2006 EU Directive bans specific families of Brominated FR’s
- Voluntary ban of all Bromine FR by the major consumer electronic OEMs by specific dates
NOFIA Polyphosphononates, A Unique FR Solution

- Unique. First of its kind
- Highly patented
- Sustainable
- Environmentally friendly
- **Non-Migrating**

Small molecules end up in environment

Plastic with current FR additives

Large molecules trapped in plastic

Plastic with NOFIA FR
## Profile for Nofia HM1100 and Nofia OL1001

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**AT** – Acute Mammalian Toxicity
- Acute Oral Toxicity (Rats)
- 28-day Repeat Dose Oral Toxicity (Rats)

**G/M** - Genotoxicity/Mutagenicity
- Ames Test
- Chromosome Aberration Test

**AA** - Acute Aquatic Toxicity
- Algae, Daphnia, Fish

**P** - Persistence (Biodegradability, water)

**B** - Bioaccumulation (Bioconcentration Factor (BCF), Fish)

**F** – Flammability

* Rating for All Non-Biodegradable Polymers
Barriers & Opportunities for Green Chemicals

Barriers:

• Customer Skepticism
• Fit in selected application – must meet all requirements
• Must be cost competitive

Opportunities to Overcome Barriers:

• Development of complete data package – demonstration of product fit,
• Provide customers with starting formulation for their evaluations,
• Ensure that cost competitiveness is “built-in” to R&D efforts up front – avoid it being an after thought,
• Legislation
FRX Case Studies

Migration:

• Key competitive advantage for Nofia

Textiles / Carpeting:

• Migration - key issue with customers & NGO’s
• Nofia solves this issue in all applications, a recent example
• Studies show high levels of brominated FR additives in pets and small children,
• Has led to legislation in California aimed at limiting the use of all FR additives – Boiling water to Frying pan syndrome

➢ FRX has demonstrated that there is no need to compromise between fire safety and chemical exposure.
FRX Case Studies

BioPolymers:
- Important new materials – ambitions to grow in all markets
- Pull from some key OEM’s
- FR and overall properties – key success factor for Hard Goods

Hard Goods:
- Application requirements: Bio Content, mechanical properties, Heat Properties, Rheological Properties, FR Properties
- How to achieve without trade offs?

- Nofia provided a unique solution due to its polymeric nature,
- Delivered FR properties while boosting all other properties exposure.
Who is pinfa?

- pinfa, the Phosphorus, Inorganic and Nitrogen Flame Retardants Association represents manufacturers and users of the three major technologies of non-halogenated flame retardants
- pinfa was established in 2009 as a Sector Group within Cefic, the European Chemical Industry Council
- expanded to NA as stand-alone, but connected organization in 2011
- It counts 23 companies all working in the FR plastics supply chain
pinfa members share the vision of continuously improving the environmental and health profile of flame retardant products and offering innovative solutions for sustainable fire safety.

pinfa members share the common concept of an ideal flame retardant:
- Non-toxic
- Non migrating
- Non toxic and non corrosive gases in case of fire
- Recycleable
- Bio degradable or remains neutral as naturally occurring substances
Mission

• Promote the use of **PIN** FRs (**Phosphorus, Inorganic & Nitrogen Flame Retardants**)
• Provide information to users, legislators and other interested parties on safety, health and environmental issues related to PIN FRs
• Work with industry partners, associations and other stakeholders to support the safety and sustainability of PIN FRs
• Carry out research relevant to safety and sustainability