The times are a changing …
THE WAY TO SUSTAINABLE FLAME RETARDANTS

CLARIANT

Public

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Flame Retardants
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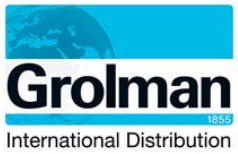
what is precious to you?

PINFA MEMBERS' SHARED VISION

- **Vision**: continuously improving the environmental and health profile of their flame retardant products, offering innovative solutions for sustainable fire safety
- **Concept** of an ideal flame retardant:
  - fit for purpose, not toxic, risk and hazard controlled
  - does not migrate out of finished products
  - does not contribute to release additional toxic or corrosive gases in case of fire
  - does not impede the recycling of finished materials
  - degradable in the environment or remains neutral as naturally occurring substances
- **Commitment**: to maintain high fire safety standards across the world, standards which minimize the risk of fire to the general public

PINFA MEMBERS (01/01/2020)



NON-HALOGEN
FIRE RETARDANT ADDITIVES

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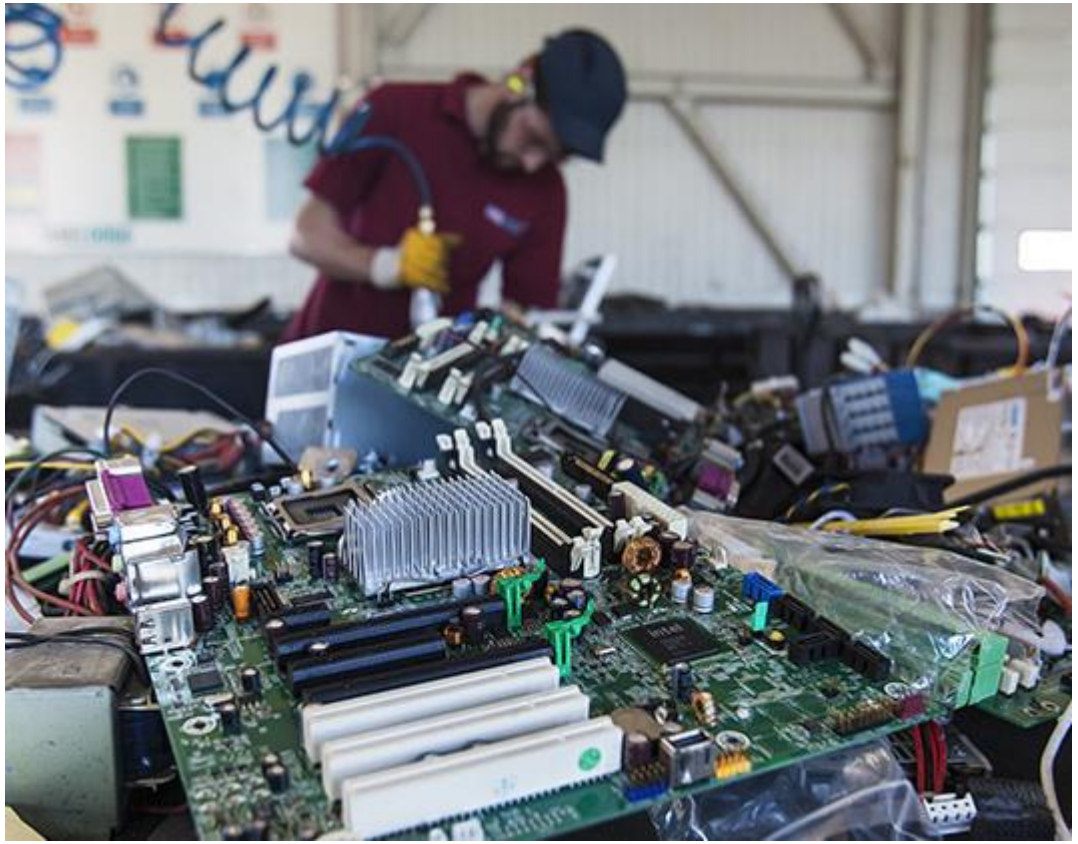
RoHS in Europe is looking at additional substance bans

- 2002/95/EC - published in 2003
- Bans Cd, Pb, Cr (VI), Hg + PBBs and PBDEs, in E&E equipment since July 2006
- Directive “recast” as 2011/65/EU – “open” scope and more substance restrictions: 4 phthalates as of 2019-07
- Flame retardants currently being evaluated*:
  - Tetrabromobisphenol-A
  - Medium-chain chlorinated paraffins
  - Antimony trioxide
- WEEE Directive recast as 2012/19/EU: Higher recycling quotas and additional product groups covered



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*See reports from Ökoinstitut Germany, with public consultations:
https://rohs.exemptions.oeko.info/index.php?id=349

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EU EcoDesign Directive for Electronic Displays - C(2019)2122

Annex (4): The use of halogenated flame retardants is not allowed in the enclosure and stand of electronic displays.

Annex (2b): Components containing flame retardants shall additionally be marked with the abbreviated term of the polymer followed by hyphen, then the symbol “FR” followed by the code number of the flame retardant in parentheses. The marking on the enclosure and stand components shall be clearly visible and readable.

Entry into force: 2021-03-01

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Several Ecolabels have restrictions on halogenated flame retardants

TCO Development

The list of flame retardants accepted under TCO Certified is growing

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TCO Certified Accepted Substance List

You can filter the list by clicking on the green header bar, or by using the search field t

Substance name/Trade name	CAS	Type	Benchmark
Aluminum diethylphosphinate	225789-38-8	FR	3
Aluminum Hydroxide	21645-51-2	FR	2
Red Phosphorus	7723-14-0	FR	2
Bisphenol A diphosphate	181028-79-5; 5945-33-5	FR, PL	3
Substituted Amine Phosphate mixture	66034-17-1	FR	2
Triphenyl Phosphate	115-86-6	FR	2
Tetrakis (2,6-dimethylphenyl)-m-phenylene biphosphate	139189-30-3	FR	3
Siloxanes and silicones, di-Me, di-Ph, polymers with Ph silsesquioxanes	68648-59-9	FR	2
Magnesium Hydroxide	1309-42-8	FR	3
Phenoxyphosphazene	890525-36-7, 2791-22-2, 2791-23-3	FR	3
Bis(2-ethylhexyl) Adipate (DEHA)	103-23-1	PL	2
Acetyl tri-butyl citrate (ATBC)	77-90-7	PL	3
Diisononyl Adipate (DINA)	33703-08-1	PL	2
Di(2-ethylhexyl) Terephthalate (DEHT)	6422-86-2	PL	3

- 26 halogen free flame retardants (Nov 2019)
- https://tcocertified.com/accepted-substance-list/

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Because REACH perceived as slow, other approaches to restrict flame retardants are being tried

photo: Shutterstock

Internet from abroad:
1600 SKR
No tax

Shop in Sweden:
2150 SKR
Full tax

Swedish Tax on Electronics (Lag 016:1067):

The tax law does not properly incentivise the substitution of problematic flame retardants, because additive phosphorus flame retardants with a good environmental and health profile are also penalized

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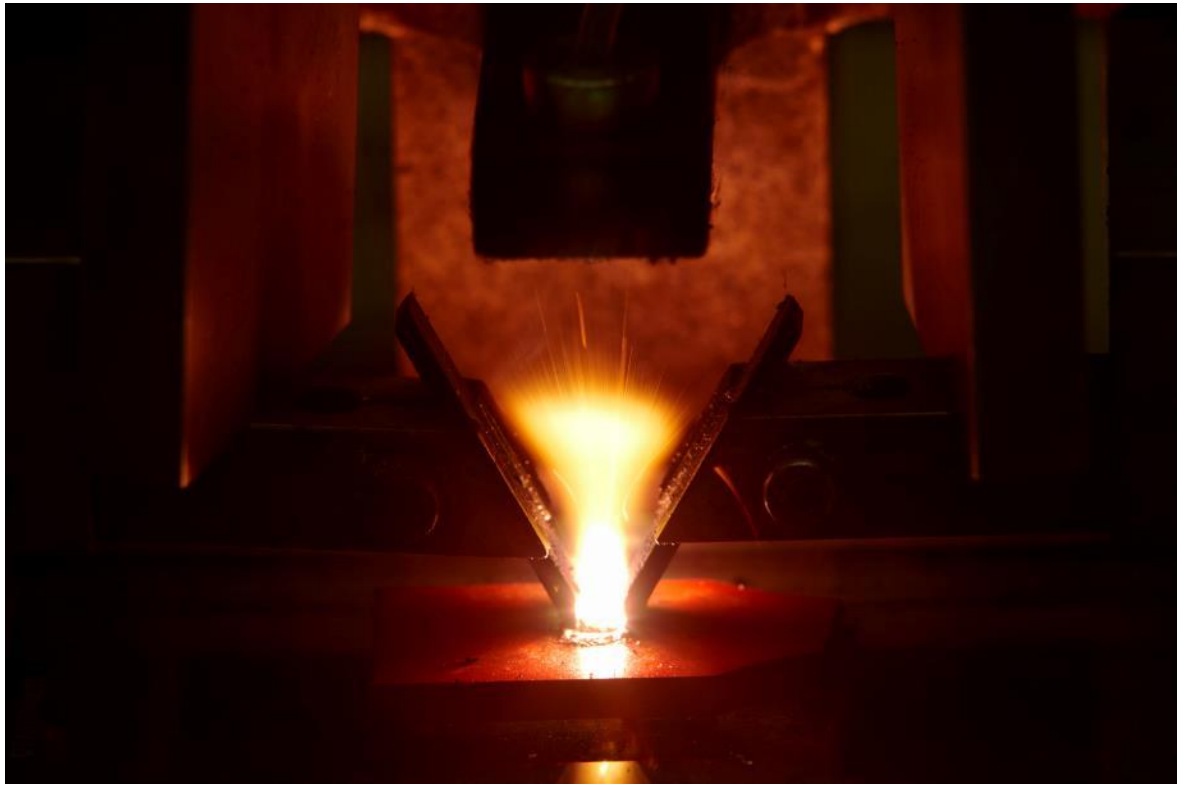
Demanding Requirements for Engineering Plastics in Connectors

- **Long-term reliability**: component and orange colour stability at elevated temperatures
- **Increased safety**: stable dielectric strength over temperature and UL94 V0 flame-retardance standard
- **Miniaturization**: enabled by maximum tracking index (CTI 600 V)
- **Complex shapes**: high-flow capability allowing thinner walls, design flexibility and size reduction (miniaturization)
- **Design flexibility**: high elongation at break and good balance of mechanical properties
- **Increased productivity**: robust processing with minimum outgassing and corrosion through wider processing window
- **Easy part traceability**: UV laser marking



Comparative Tracking Index (CTI) test, photo: © R. Baumgarten, Clariant

- http://www.dupont.com/corporate-functions/media-center/press-releases/crastin-electric-hybrid-vehicle-connectors.html

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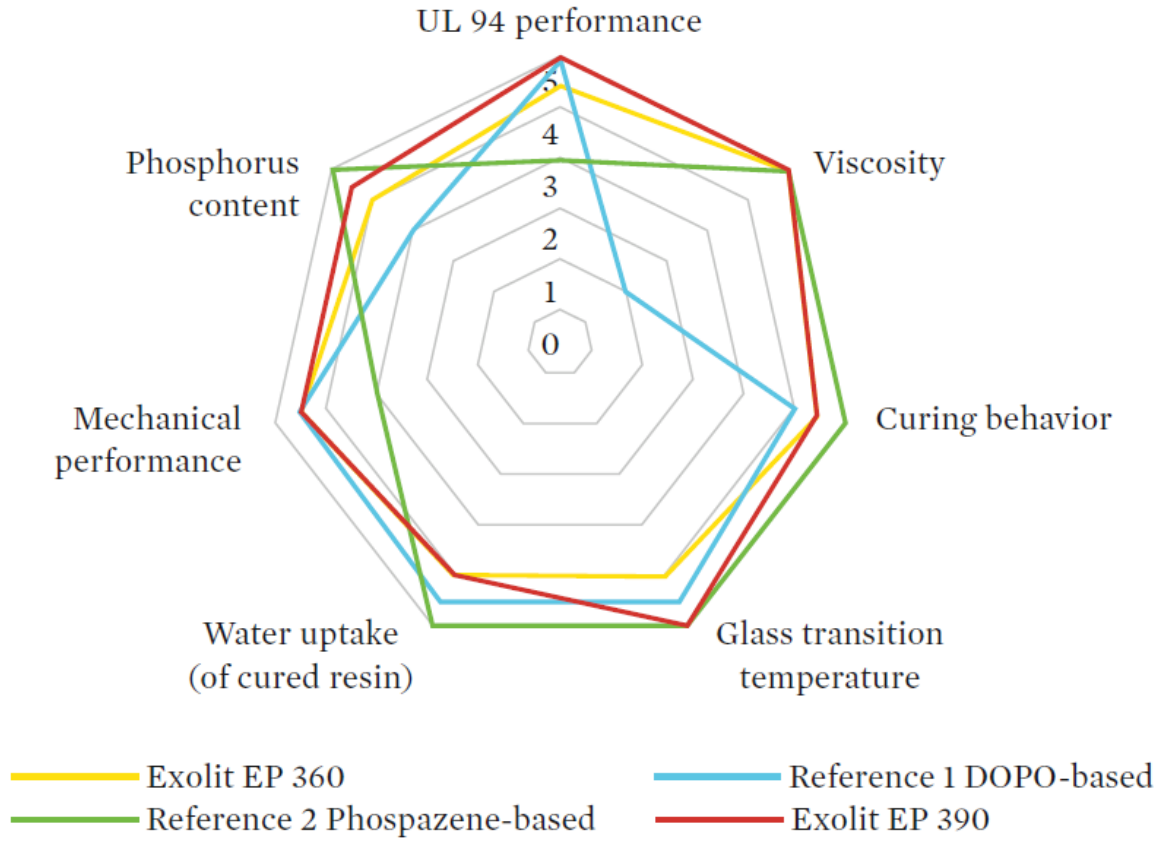
Exolit® EP 360 and EP 390 –our new flame retardants for liquid processing showing clear advantages compared to alternative products

CUSTOMER BENEFITS

- Favorable environmental health profile
- Ideal solution for all solvent-free processes like infusion and resin transfer molding processing
- Enabling to fulfill the required flame retardant performance at a low dosage
- Combination with other synergistic flame retardants possible
- Excellent curing performance
- Shows outstanding performance according to UL 94 standard



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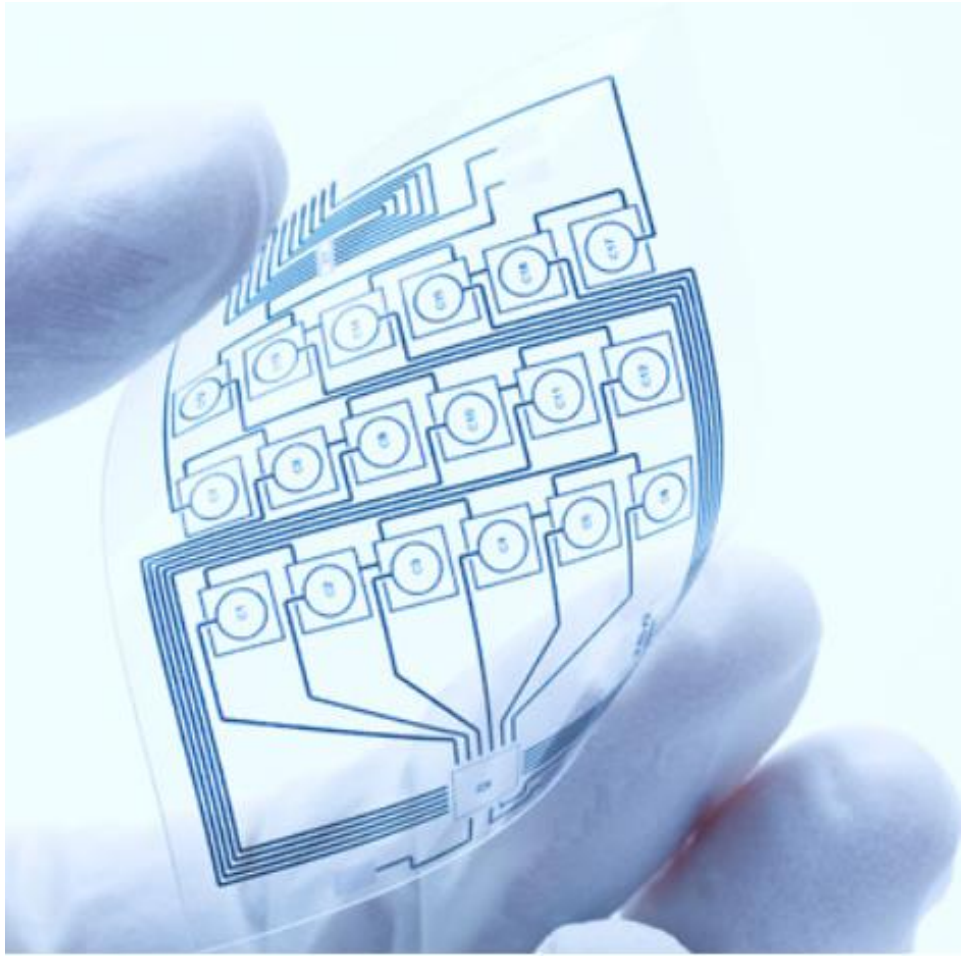
Exolit® OP 930, OP 935 and OP 945 – Clariant's flame retardants for advanced electronic materials like FCCL and PCB

KEY PRODUCT FEATURES

- Halogen-free flame retardants, high phosphorus content
- High thermal stability, ideal for lead-free assemblies
- Hydrophobic, hydrolysis resistant, low solubility in water
- Smaller particle size grades available (Exolit OP 935 and Exolit OP 945)
- Metal complexes with short-chain aliphatic phosphinic acids, protected by a wide network of patents

CUSTOMER BENEFITS

- Halogen-free, excellent choice for RoHS compliant electronic materials
- Very limited impact on properties (Dk, Df, T_g)
- No increased water take-up in Pressure Cooker test



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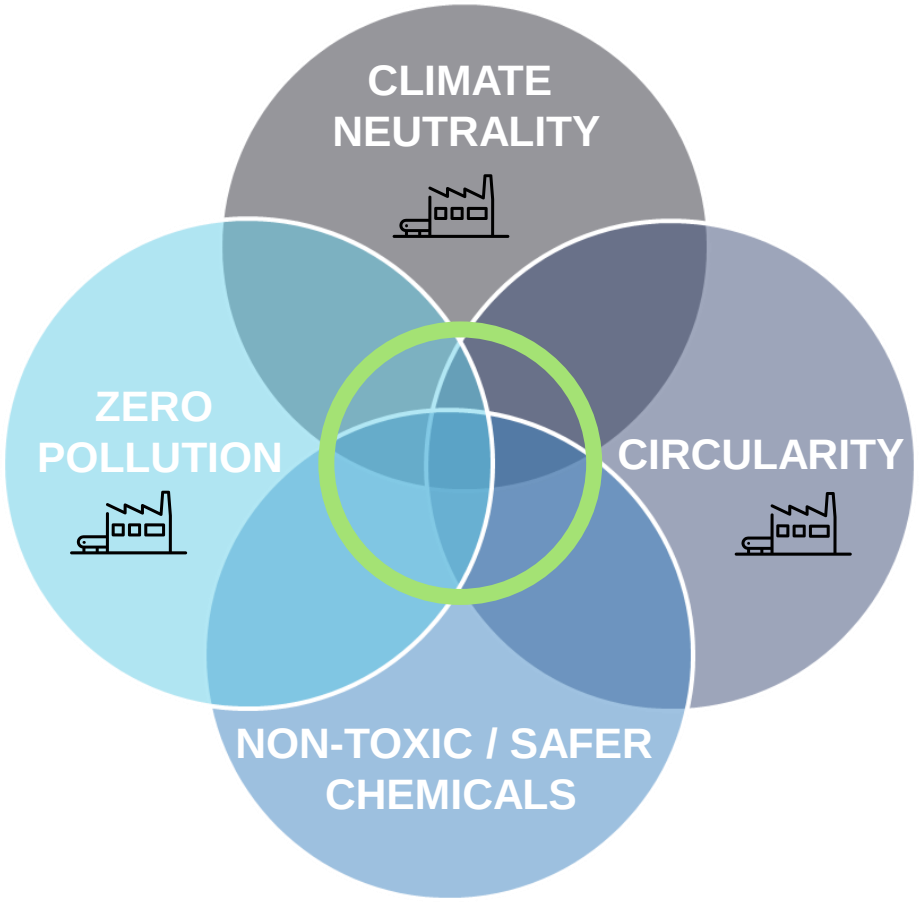
While climate neutrality is important, the sustainability sweet spot is when all four sustainability dimensions are addressed



CLIMATE-NEUTRAL AND SUSTAINABLE OPERATIONS

Setting clear goals for operations that deliver to stakeholder expectations and the new policy agenda will help to **future-proof our operations**

SUSTAINABILITY-DRIVEN PORTFOLIO CHANGE

Deploying our innovation and product stewardship capabilities to accelerate sustainability-driven portfolio change will help to **future-proof our product portfolio**

“sweet spot”
depends on application, value chain, markets and our capabilities to deliver; ideally all objectives are delivered

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The Portfolio Value Program: the home for discovering EcoTain® products

The Portfolio Value Program implements tools and processes to screen and move Clariant's product portfolio towards **increased sustainability performance**.

The PVP is developed with the Collaborating Centre on Sustainable Consumption and Production (CSCP), a renowned »think and do tank« founded by the UNEP and the Wuppertal Institute.

It takes a **two-sided look at product sustainability** assessing:

the sustainability performance **against the market**, and

the **absolute** sustainability **risks and benefits** of the product

PEOPLE	PLANET	PERFORMANCE
Safe use, transparency and information	Raw materials and sustainable sourcing	Integrated sustainable business
Addressing megatrends and social needs	Resource efficiency and environmental protection	Performance advantages

With a focus on **holistic and life cycle thinking** and the identification of EcoTain® products and solutions.

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EcoTain® Label – our approach to sustainability

ECOTAIN®

EcoTain® is our **flagship label for sustainability** excellence products and solutions.
It highlights solutions offering outstanding sustainability advantages and add value to customers and the society as a whole.

Each product and solution carrying the EcoTain® label has undergone a systematic, **in-depth screening process** using 36 criteria spanning all three sustainability dimensions: **social, environmental and economic**.

Its ambitious benchmark **distinguishes products** that

- significantly exceed market standards in general,
- have best-in-class performance in one or several criteria, and
- make overall sustainability contributions.

EcoTain® products support actively the sustainability efforts of our customers, **without compromising on performance**.

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Exolit® OP phosphinate flame retardants achieve EcoTain® label

– Clariant awards its EcoTain sustainable excellence label to products in its portfolio that provide sustainable benefits above market standard and therefore represent best-in-class solutions. These phosphinate based flame retardants have achieved the EcoTain® label:

EXOLIT® OP 1230

EXOLIT® OP 1240

EXOLIT® OP 1400

EXOLIT® OP 930

EXOLIT® OP 935

ECOTAIN®

– Third party assessments have confirmed Exolit® OP's environmental and health profile

Umwelt Bundesamt

German Environment Protection Agency (UBA)
more

US Environment Protection Agency Design for Environment projects
more

ENFIRO research project funded by the European Commission
more

GreenScreen® Practitioner Program

GreenScreen Assessment (benchmark 3, revision 2016-10. DEPAL)

Fraunhofer UMSICHT

Marzi T., Beard A. (2006): The ecological footprint of flame retardants: A case study. Specialty Chemicals Magazine, pp. 28–30

Beard A, Hoerold S (2013): Are halogens really necessary? Kunststoffe Int. pp. 25-26, available online

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Exolit® OP TERRA solutions derived from renewable hydrocarbons for plastics, coatings and adhesives applications

BENEFITS

- Raw materials, C_2/C_3 monomers, derived from 100% renewable feedstock such as fat residues and discarded cooking oil
- Mass balance certification for usage of renewable ethylene and propylene
- Drop-in additive solutions without compromising on quality and performance, no additional testing or approvals needed
- Reducing carbon emissions and crude oil dependency
- Most solutions carry Clariant's EcoTain® label
- In collaboration with NESTE

Exolit® OP Terra flame retardants
Licocene® Terra performance polymers
Licocene® Terra performance waxes

ECOTAIN®

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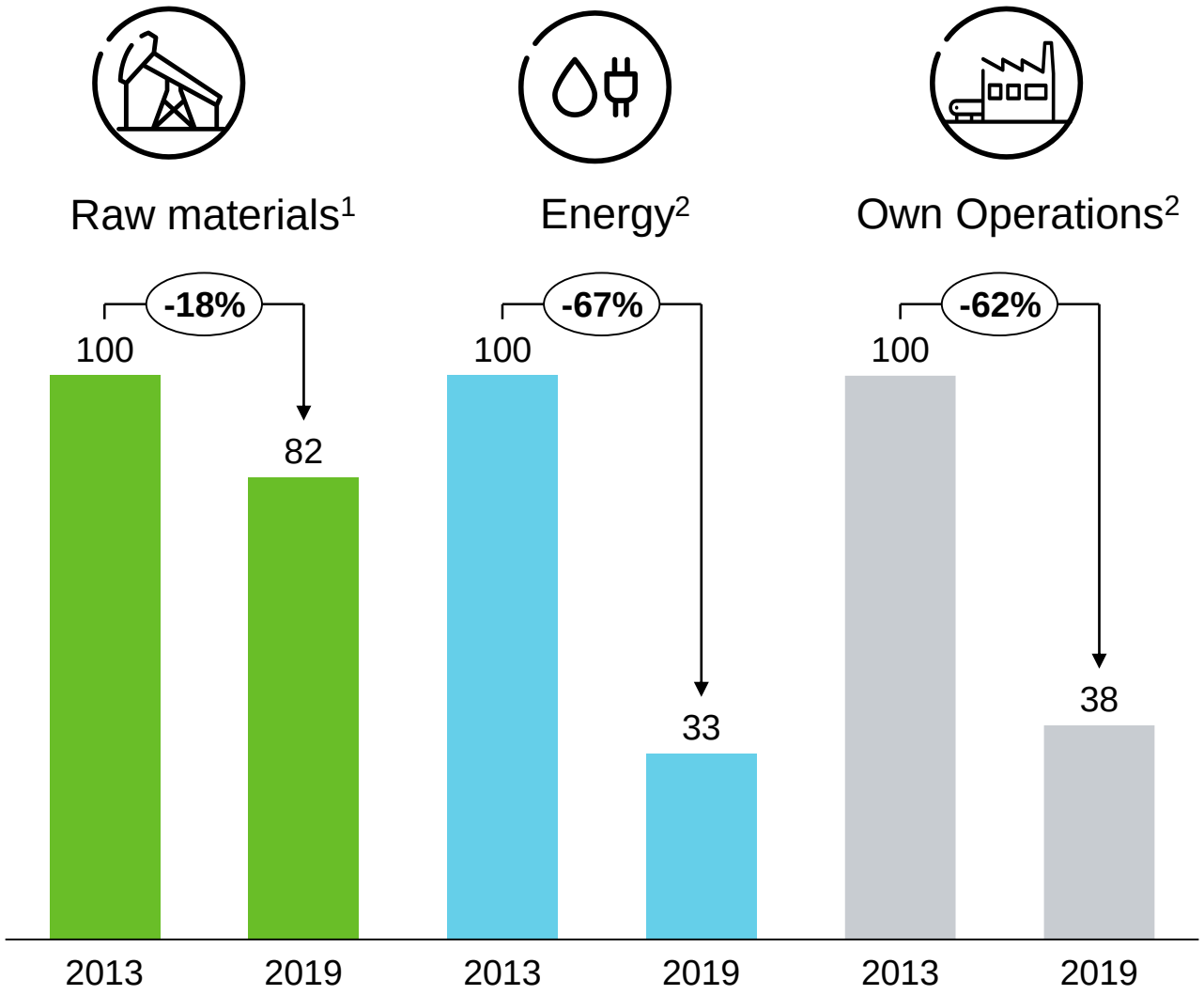
Exolit OP TERRA: Carbon footprint can be lowered by ca. 20%



DEPAL (cradle-to-cradle) t CO_{2e}/ mt produced:

- offering of Exolit OP Terra and
- shift to renewable electricity in Knapsack
- less emissions and higher efficiency for own operations

The savings related to the amount of DEPAL sold in 2018 avoided > 1’500 homes annual electricity consumption

In addition, DEPAL supports recycling of polyamides and enables increased recyclate usage in E&E and automotive applications

[1] Considering DEPAL specific product. [2] Considering Knapsack site average

Circular Plastics Economy:
Recycling of halogen-free flame retarded plastics

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www.lbf.fraunhofer.de

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The Problem

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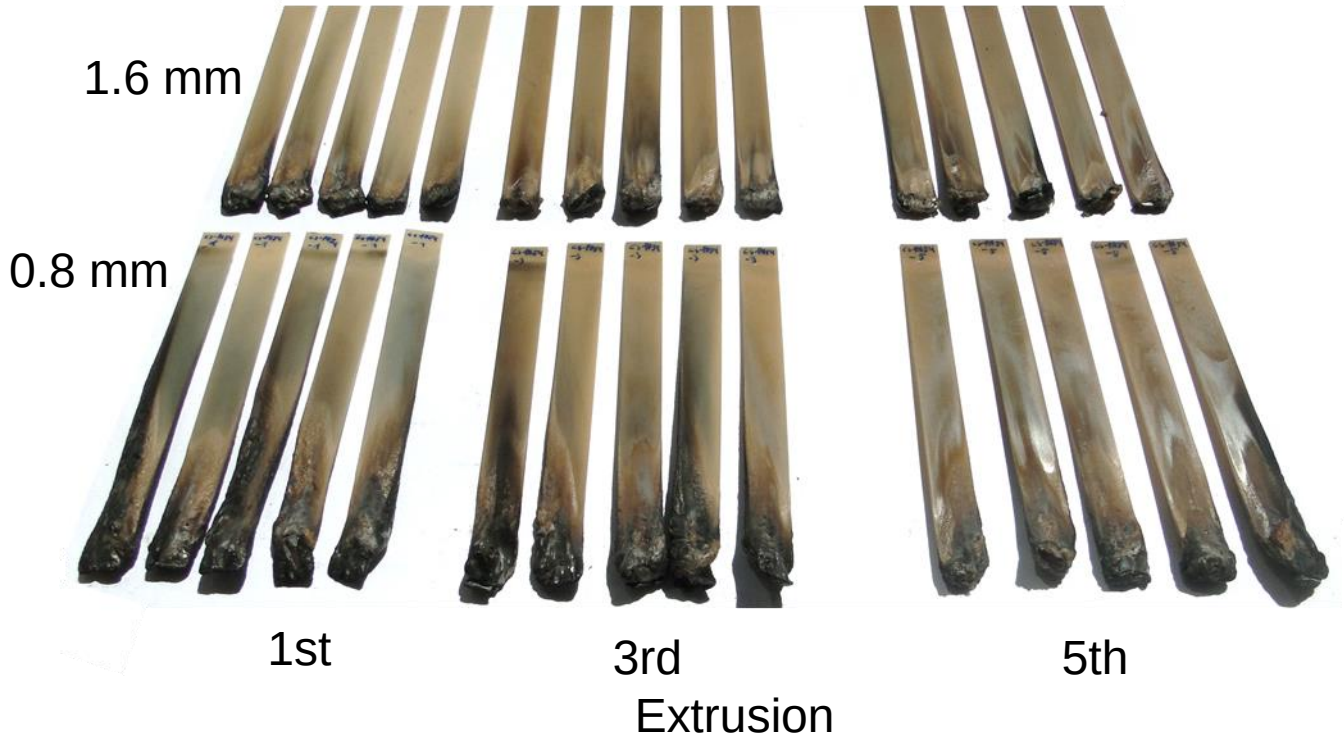
Recycling of Polyamides with Exolit phosphinates: Flammability rating is maintained

Flame retardancy V-0 classification is maintained even after 5 extrusion cycles and on oven-aging for 1000 hours at 120 °C



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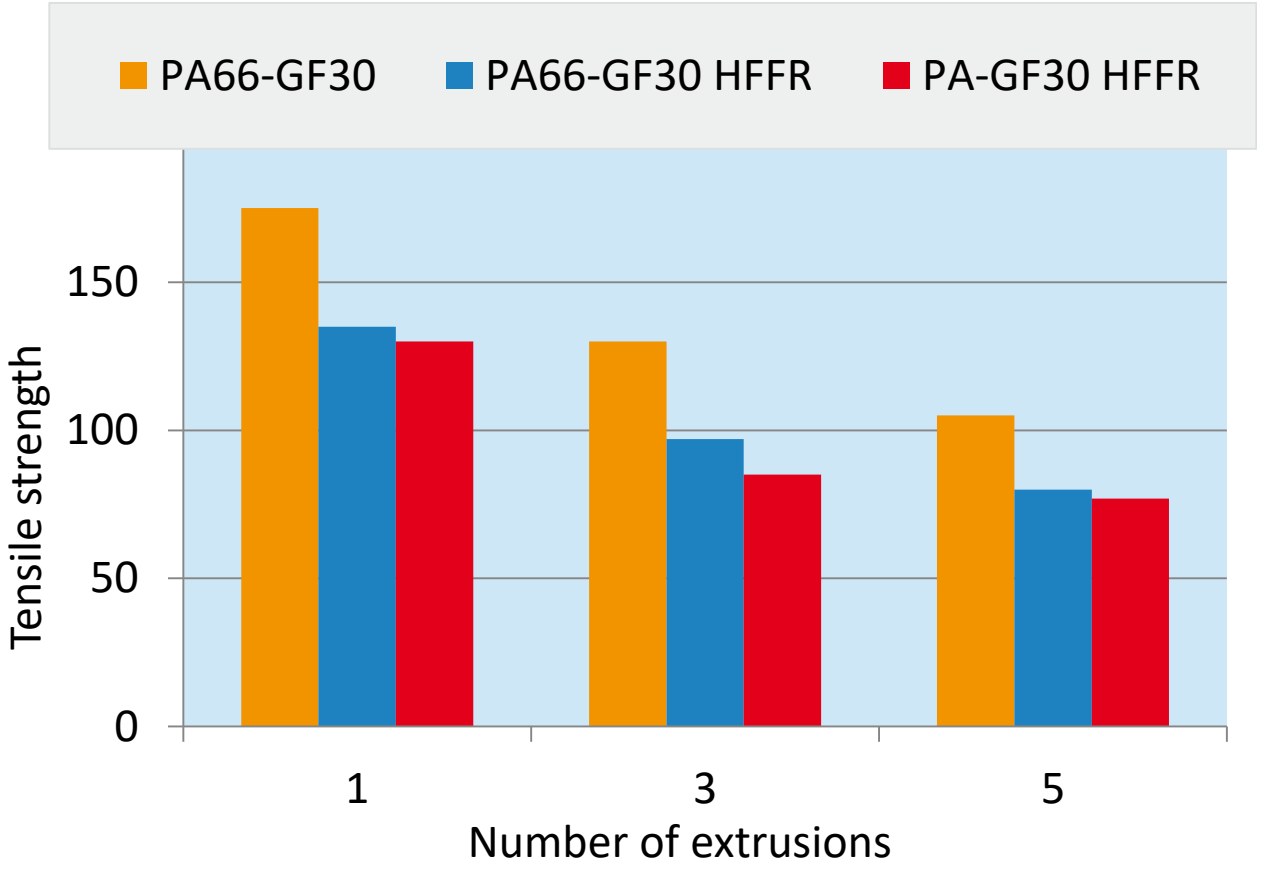
Recycling of Polyamides with Exolit phosphinates: Mechanical properties are only slightly reduced

Fiber length reduction during recycling steps decreases slightly mechanical properties, but does not influence flame retardancy



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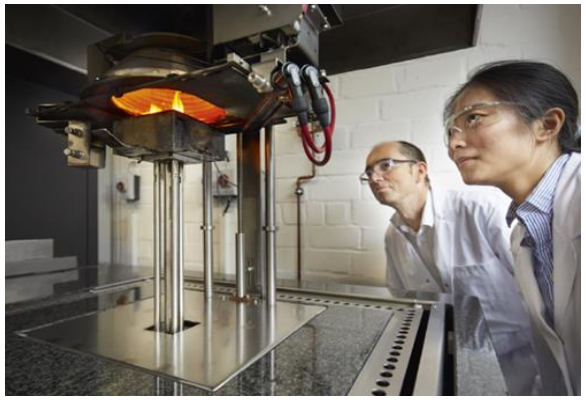
Conclusion

- Restriction of flame retardants by legislation and ecolabels drive transition to halogen free flame retardants in many areas
- Industry is doing a lot to reconcile fire safety and environmental profile:
  - Product assessments, carbon footprint, recycling, …
  - Collaborate on positive lists of FRs
  - Clariant's portfolio value programme and new products
- Performance requirements for flame retardants get more demanding



Thank you

FOR YOUR ATTENTION

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