X EDIZIONE

SMART PLASTICS

'TECNOPOLIMERI A CONVEGNO'

17 | 18 MAY 23

MUSEO STORICO ALFA ROMEO

FLAME RETARDANT COMPOUNDS: NEW RECYCLING OPPORTUNITIES

Arese 17-18 Maggio 2023

Micaela Lorenzi, GREENCHEMICALS Srl

PALMAROLE AG

GC GreenChemicals IMPROVE YOUR PERFORMANCE & PALMAROLE

UV ABSORBERS • ANTIOXIDANTS • FLAME RETARDANTS
NUCLEATING & CLARIFYING AGENTS

plast PLAST:DESIGN

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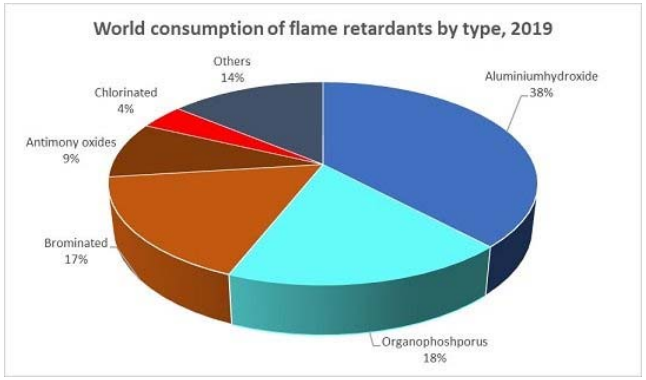
- **FR 2,2 MILLIONS MTs/YEAR, WITH GROWTH OF 3%/YEAR.**
- **1/3 ARE HALOGENATED WITH ANTIMONY TRIOXIDE AS SYNERGIST**



HALOGENS AND ANTOMONY TRIOXIDE CONCERNS

- Endocrine and systemthyroid disruption
- Impacts to the immune
- Reproductive toxicity
- Cancerogenic
- Adverse effects on fetal and child development
- Neurologic function

CRITICAL POINTS FOR HALOGEN FREE BROS

1) MECHANICAL PROPERTIES, due to higher loading level and low melting point;
2) PRICE GAP
3) LOWER TEHERMAL STABILITY

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BROMINATED FR

R-Br

- Br* → HBr
- Br*, H*, R* + O_2 → R-O-O*
- R-O-O* + R → R-O-O-H + R*
- R-O-O-H → RO* + OH*

RED P, PHOSPHATE AND PHOSPHINATES

RED-P

- P → PO*

PHOSPHINATE

- HPO_4
- PO*

PHOSPHATE

- HPO_4
- PO* H_2O

HBr/ HPO_4 IS CAUSING ACIDITY IN EXTRUDER, RUST AND CORROSION AND DEPOLIMERIZATION (MFI INCREASE WITH LOST OF MECHANICAL PROPERTIES IN PA/PET/PBT/PC !

RADICALS ARE RESPONSIBLE FOR MFI INCREASE IN MANY POLYMERS, WITH BIG DECAY OF MECHNICAL PROPERTIES; THEY ARE ALSO CHANGING COLOR, PROMOTING OXIGEN REACTION ON POLYMER CHAIN; PEROXIDES ARE GENERATING VERY FAST NEW RADICALS, MAKING RADICAL GROWING CURVE, EXPONENTIAL.

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POLYPROPYLENE

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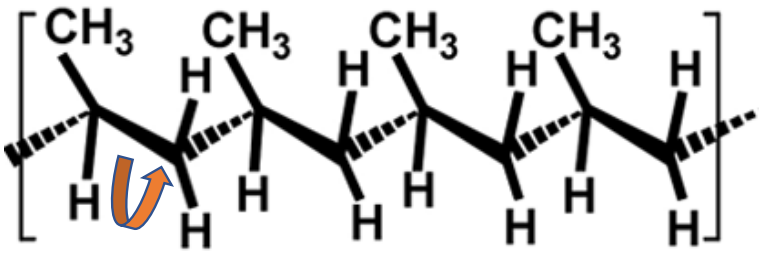
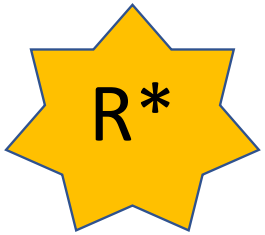


LOI	
PS	17
ABS	18
PA	24
PC	27
PP	17



HIGH LOI → **BAD FLAME RETARDANT RESISTANCE**

N AND O IN CHAIN → **ALL FLAMABLE GASES**

LOW PROC. TEMP. 200°C-280°C → **WIDE RANGE OF FR**

NO PRESENCE OF N AND O → **BAD CHAR**

RADICAL POLYMERIZATION / ZIEGLER NATTA → **DRIPPING**

CROSS-LINKING ABILITY → **VERY BAD**

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X EDIZIONE SMART PLASTICS 'TECNOPOLIMERI A CONVEGNO' 17 | 18 MAY 23 MUSEO STORICO ALFA ROMEO

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FR POLYPROPYLENE FORMULATIONS

FLAME RETARDANT PACKAGE	TEST	TYPE OF FR	DOSAGE
GC DPE 81+ Sb_2O_3	UL94 V0	HALOGEN + Sb	22%
GC HF 1000 (intumescent)	UL94 V0	HALOGEN FREE	27%
GC BDDP 68+ Sb_2O_3	UL94 V2	HALOGEN + Sb	4%
GC DRIPP HF 70 (low Halogen)	UL94 V2	HALOGEN FREE	2%
GC HF D 40 (Halogen free)	UL94 V2	HALOGEN FREE	6-8%

X EDIZIONE

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FR POLYPROPYLENE MECHANICS

TEST TYPE	IZOD ISO 180 (KJ/m^2 with cut)	IZOD ISO 180 (KJ/m^2 without cut)	YIELD STRENGTH (N/mm^2)	ELONGATION BREAK (%)
PPV2 LOW HALOGEN	2,25	47,9	32,85	11,43
PPV2 HALOGEN	1,88	38,7	34,22	13,81
PPV0 HALOGEN	1,94	38,13	29,44	17,99
PPV0 HALOGEN FREE	1,63	15,16	27,38	6,03

HALOGENATED PP V0 WITH AND WITHOUT STABILIZATION

X EDIZIONE
SMART PLASTICS
'TECNOPOLIMERI A CONVEGNO'
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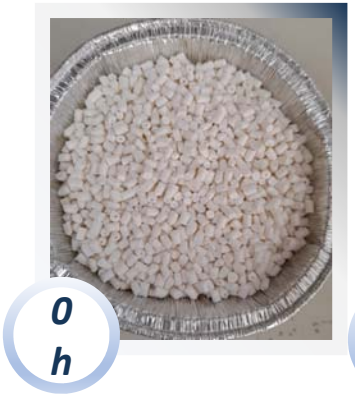
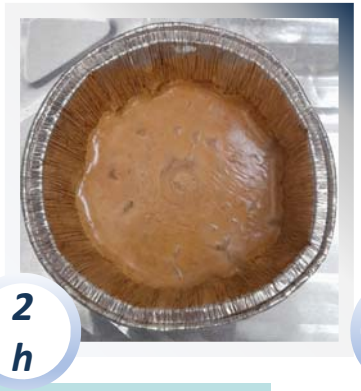
PP HAL= PP + 22% MB PP DETO 31

Compound has been kept at 200 °C for different time.





PP HAL st = PP + 22% MB EVA DETO 31 + MB PO POX 20-4

MUCH MORE STABLE!

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HALOGENATED PP V2 WITH AND WITHOUT STABILIZATION

X EDIZIONE
SMART PLASTICS
'TECNOPOLIMERI A CONVEGNO'
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Compound has been kept at 200 °C for different time.

PP HAL= PP + 6 % MB PP BATO 21


0 h


1 h


2 h


4 h

PP HAL= PP + 6 % MB PP BATO 21 + MB PO POX 20-4


0 h


1 h


2 h


4 h

MUCH MORE STABLE!

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HAL FREE PP V0 WITH AND WITHOUT STABILIZATION

X EDIZIONE
SMART PLASTICS
'TECNOPOLIMERI A CONVEGNO'
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PPV0 HALOGEN FREE = PP + 27 % HF1000

Compound has been kept at 200 °C for different time.

PPV0 HALOGEN FREE = PP + 27 % HF1000 + MB PO POX 20-4

HAL FREE PP V2
WITH AND WITHOUT STABILIZATION

X EDIZIONE
SMART PLASTICS
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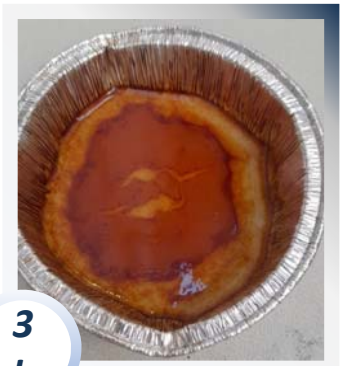
PPV2 HALOGEN FREE = PP + 2% GC DRIPP HF 70

Compound has been kept at 220 °C for different time.


1 h


2 h


3 h


4 h

PPV2 HALOGEN FREE st= PP + 2% GC DRIPP HF 70 + MB PO POX 20-4


1 h


2 h


3 h


4 h

MUCH MORE STABLE!

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POLYAMIDE

X EDIZIONE
SMART PLASTICS
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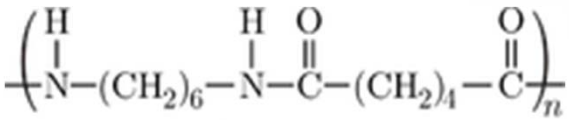
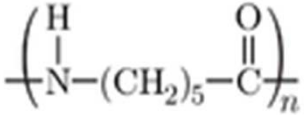
IMPROVE YOUR PERFORMANCE



Nylon 66



Nylon 6

LOI	
PE	17
ABS	18
PA	24
PC	27
PTFE	95

MAIN FR FEATURES

HIGH LOI	GOOD FLAME RESISTENCE
N AND O IN CHAIN	LESS FLAMMABLE GASES
HIGH PROCESSING T, 230°C – 280°C	FR MUST BE THERMAL RESISTANT
PRESENCE OF N AND O	CHAR
POLICONDENSATION	DRIPPING
CROSS-LINKING ABILITY	CROSS-LINK

R*

ACIDITY

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X EDIZIONE

SMART PLASTICS

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FR POLYAMIDE FORMULATIONS

FLAME RETARDANT PACKAGE	TEST	FR TYPE	DOSAGE
GC DPE 81+ Sb_2O_3	UL94 V0, 30%GF	HALOGEN + Sb	20%
GC BPS 67+ Sb_2O_3	UL94 V0, 30%GF	HALOGEN + Sb	22%
GC PAP 12 (PHOSPHINATE)	UL94 V0, 30%GF	HALOGEN FREE	18%

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HALOGENATED PA V0 WITH AND WITHOUT STABILIZATION

X EDIZIONE
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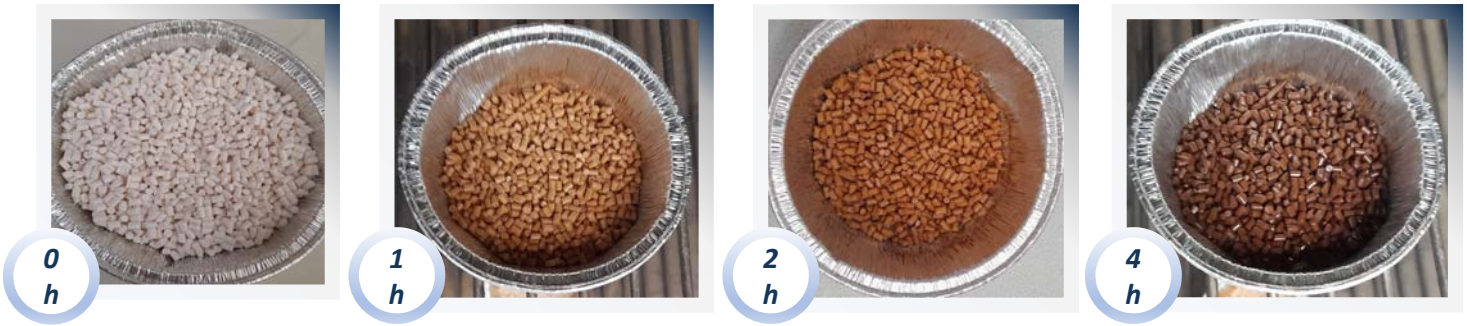
Compound has been kept at 220 °C for different time.

PA HAL= PA66 + 20% MB EVA DETO 31



PA HAL= PA66 + 20% MB EVA DETO 31 + MA PA POX ED71

MUCH MORE STABLE!

plast PLAST:DESIGN

HAL FREE PA V0
WITH AND WITHOUT STABILIZATION

Compound has been kept at 220 °C for different time.

X EDIZIONE
SMART PLASTICS
'TECNOPOLIMERI A CONVEGNO'
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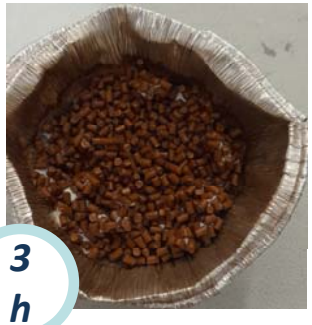
1 h


2 h


3 h


4 h

PAV0 HALOGEN FREE PA + 18 % GC PAP 12


1 h


2 h


3 h


4 h

PAV0 HALOGEN FREE PA + 18 % GC PAP 12+ STANDARD STABILIZATION


1 h


2 h


3 h


4 h

PAV0 HALOGEN FREE PA + 18 % GC PAP 12+ + GC PA POX ED71

POLYBUTYLEN TEREPHTALATE

X EDIZIONE
SMART PLASTICS
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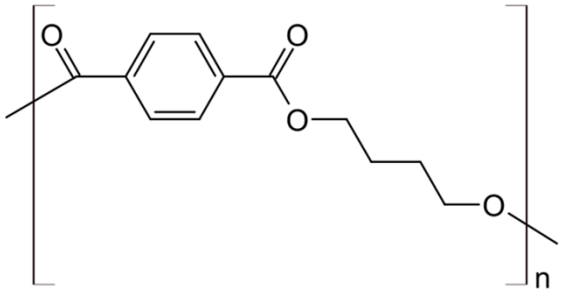


LOI	
PE	17
ABS	18
PET	24
PBT	23
PC	27
PTFE	95

R*

HIGH LOI → **GOOD FLAME RESISTANCE**

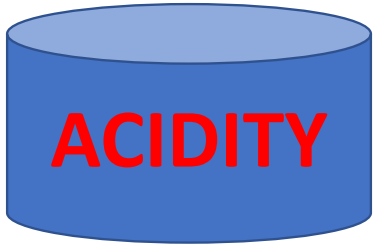
PRESENCE OF ETEROATHOMS → **NOT FLAMABLE GASES**

T PROCESS PET 260°C – 290°C
PBT 230°C-270°C → **FR MUST BE THERMAL RESISTANT**

ETEROATHOMS IN CHAIN → **CHAR**

POLYCONDENSATION → **DRIPPING**

EASY TO CURE → **CROSS-LINK**



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FRX POLYMERS

X EDIZIONE
SMART PLASTICS
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nofia
HALOGEN FREE POLYMERIC
FLAME RETARDANT

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NOFIA HM1000

Phosphonate omopolymer, 10,5 % P, Tm= 110-120°C

- Polymeric, Hal free, P based flame retardants.
- GreenScreen 3, ChemFORWARD SAFER B. Oekotex 100 listed, RoHS, TCO – all compliant.
- Use in inherently FR Polyester fiber. Including rPET.
- Also use in molded and extruded PET. Including rPET.
- Replacement for KPFBS in thin PC sheet and molded compounds. Transparent and filled.
- Use in PC/ABS, and other PC blends, to get V0 at 0.8mm, with up to +30C HDT improvement.
- In PU used in Auto interior for Chinese quality low odor, and meet VDA 278.
- Also part of formulation to replace TCPP + Melamine in British Standard foam
- Use in graphite free PU formulae for “Under hood”, EVs and other.

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PBT

X EDIZIONE
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GC DPE 81+ Sb_2O_3	UL94 V0	HALOGEN + Sb	20%
GC BPS 67+ Sb_2O_3	UL94 V0	HALOGEN + Sb	22%
NOFIA + MPP+PTFE	UL94 V0	HALOGEN FREE	25%
NOFIA + MPP+PTFE+GF30	UL94 V0	HALOGEN FREE	30%

TEST TYPE	IZOD ISO 180 (KJ/m^2 with cut)	IZOD ISO 180 (KJ/m^2 without cut)	YIELD STRENGTH (N/mm^2)	ELONGATION BREAK (%)
PBT GF 30%	9,5	36,00	55	2,7
PBT V0 HALOGEN FREE	2,18	16,18	46	1,6
PBT V0 GF 30% HALOGEN FREE	2,25	17,44	50,6	1,9

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PBT

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SMART PLASTICS
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Compound has been kept at 220 °C for different time.

PBT HAL= PBT + 20% MB EVA DETO 31


1 h


2 h


3 h


4 h

PBT HAL= PBT + 20% MB EVA DETO 31 + MB EVA POX 900


1 h


2 h


3 h


4 h

MUCH MORE STABLE!

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HALOGEN FREE PBT V0

X EDIZIONE SMART PLASTICS 'TECNOPOLIMERI A CONVEGNO' 17 | 18 MAY 23 MUSEO STORICO ALFA ROMEO

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Compound has been kept at 220 °C for different time.

PBT HAL= PBT + 15% NOFIA HM1000 + 10% MPP

FRX POLYMERS

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CONCLUSIONS

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- IMPROVEMENT IN TECHNOLOGY AND ECONOMICAL CHANGE MAKE *HALOGEN FREE MORE INTERESTING*
- KNOWN HALOGEN FREE FORMULATIONS ARE GENERALLY *LESS RECYCLABLE*.
- IT'S CLEAR THAT *FLAME RETARDANT COMPOUND CAN BE RECYCLED*

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