



ADAPTING MATERIALS TO ELECTRIFICATION CHALLENGES

NANCY ZILLI / XAVIER COUILLENS

UL WEBINAR (NOVEMBER 2022)

DOMO AT A GLANCE



2,150



€1.5 Bill.



9 OPERATION SITES



6 INNOVATION & TECHNICAL centres

MARKETS



AUTOMOTIVE



INDUSTRIAL & CONSUMER GOODS



ELECTRIC & ELECTRONIC

POLYAMIDES

PA 6

PA 6.6

PA 6.10

PA HT

TECHNYL® TRADEMARKS

TECHNYL® PURE 
Electro-friendly polyamide

TECHNYL® PROTECT 
Flame retardants

TECHNYL® STAR 
High-flow PA6 & PA66

TECHNYL® ONE 
Enhanced electrical properties

TECHNYL® 4EARTH 
Sustainable polyamide



Miniaturization



Digitalization



Mass
customization



Less NOx and
CO₂ emission



Lightweighting



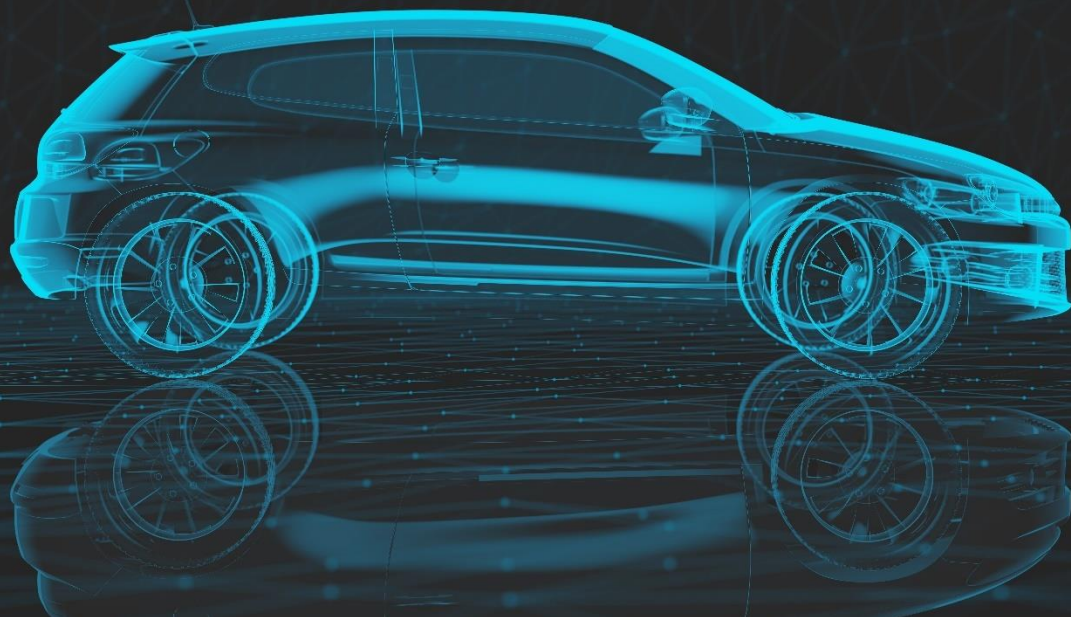
Vehicle
electrification



Connectivity



Energy
Management



POLYAMIDES: KEY ENGINEERED MATERIALS FOR AUTOMOTIVE

- **Since 1953, TECHNYL®** has offered the **full range of polyamide 6/6.6/HT-based solutions** for a diverse range of applications used every day, around the world.
- As automotive market is going through **fast transformation**, keeping close to rapidly evolving material needs and **bringing innovative solution** has a priority for Domo to meet E-mobility materials expectation:

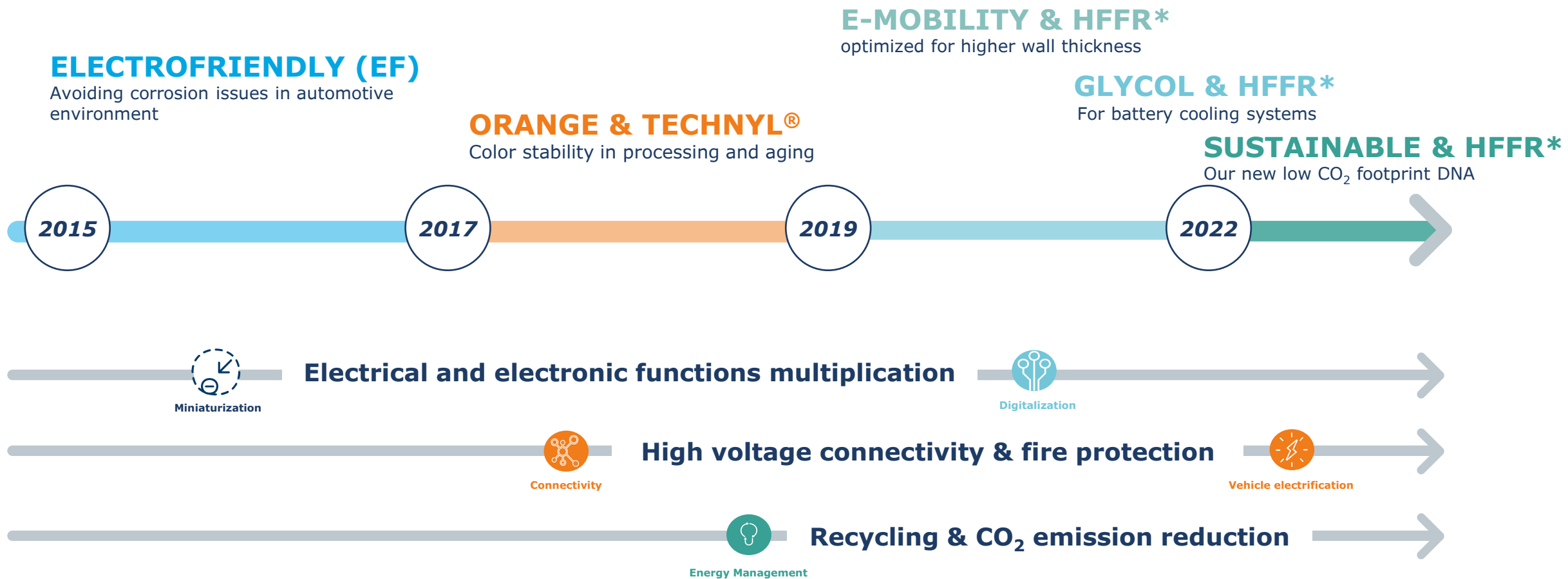
→ **ELECTRIFICATION**

→ **SAFETY**

→ **SUSTAINABILITY**

→ **COMPETITIVITY**

FOLLOWING UP EACH STEP OF THE E-WAY FROM MORE MATURE TO MORE INNOVATIVE SOLUTIONS





A

● | **E-safety:** Corrosion & TECHNYL® PURE

D

● | **E-safety:** Orange & TECHNYL®

N

● | **DOMO HFFR core competency** to support AUTO

E

● | **Optimized TECHNYL® HFFR** for thicker wall parts

G

● | **Cooling safety:** Glycol & TECHNYL® HFFR

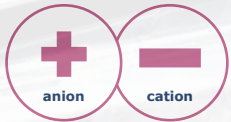
A

● | **Conclusions**



- **E-safety: Corrosion & TECHNYL® PURE**
- | E-safety: Orange & TECHNYL®
- | **DOMO HFFR core competency** to support AUTO
- | **Optimized TECHNYL® HFFR** for thicker wall parts
- | **Cooling safety: Glycol & TECHNYL® HFFR**
- | **Conclusions**

THE 4 DRIVERS FOR PROBLEMS



CONTAMINANTS

Need to be:

- In contact with metals
- In an active form



HUMIDITY

Could act on:

- Transport
- Solubility



TEMPERATURE

Could act on:

- Transport
- Kinetics



TENSION

Could act on:

- Transport
- Structuration

TECHNYL[®] PURE : PREVENTING PROBLEMS

CORROSION



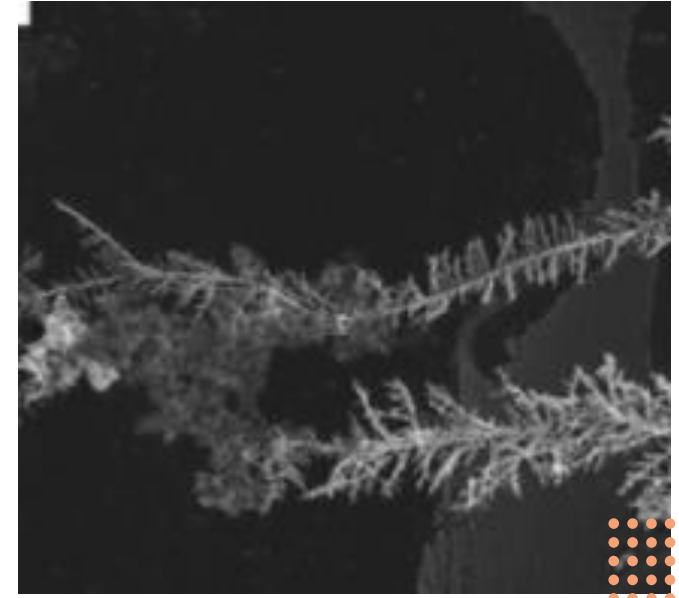
Electrical efficiency **DECREASE**
through corrosion

PASSIVATION (or deposition)



Electrical efficiency **DECREASE**
through deposition

STRUCTURATION (or dendrites)



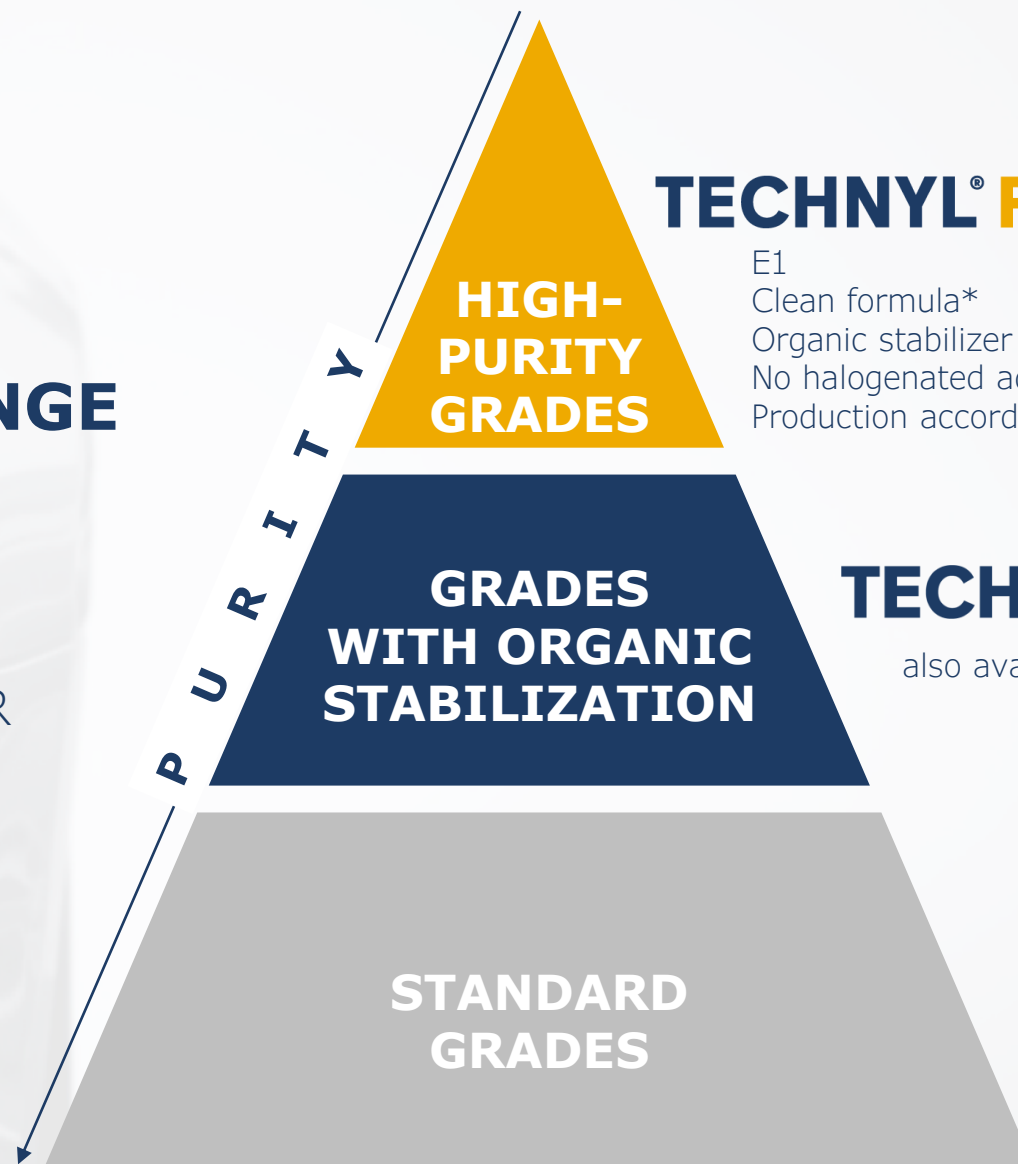
Electrical conductivity **INCREASE**
through architecture build-up

THE TECHNYL RANGE

OF SOLUTIONS FOR

ELECTRONICS

FROM ORGANIC STABILIZER
TO CLEAN FORMULA



TECHNYL® PURE

- E1
- Clean formula*
- Organic stabilizer
- No halogenated additives
- Production according to GMP to avoid cross contamination

GRADES WITH ORGANIC STABILIZATION

TECHNYL® A 219 V30 BK

also available as **ORANGE**

STANDARD GRADES

* Typical <50ppm halogen

TECHNYL[®] PURE : A COMPLEMENTARY OFFER



POLYAMIDE

PA6.10/PA66

PA66

PA6



COLORS

BLACK COLOR



PROPERTIES

NON-FR



BENEFITS

GLYCOL STABLE


HEAT STABLE

LASERMARKING


PROCESSABILITY

TECHNYL[®] PURE A COMPLETE RANGE WITHOUT INORGANIC STABILIZER (COPPER-FREE) AND PRODUCED ACCORDING TO GMP

E+ Coding	Polymer Type	E+ Grades	Heat resistance	Glycolysis
E1 < 50 ppm	PA 6.10/PA 66	TECHNYL PURE D 219E1CR V33 BK	+	+++
	PA 66	TECHNYL PURE AF 219E1 V30 BK	+	+
		TECHNYL PURE A 219E1 V33 BK	+	+
		TECHNYL PURE A 219E1 V30 BK	+	+
		TECHNYL PURE A 216E1 V25 BK	-	-
	PA 6	TECHNYL PURE C 219E1 V30 BK	+	-
		TECHNYL PURE C 219E1 V50 BK	+	-



NEW!



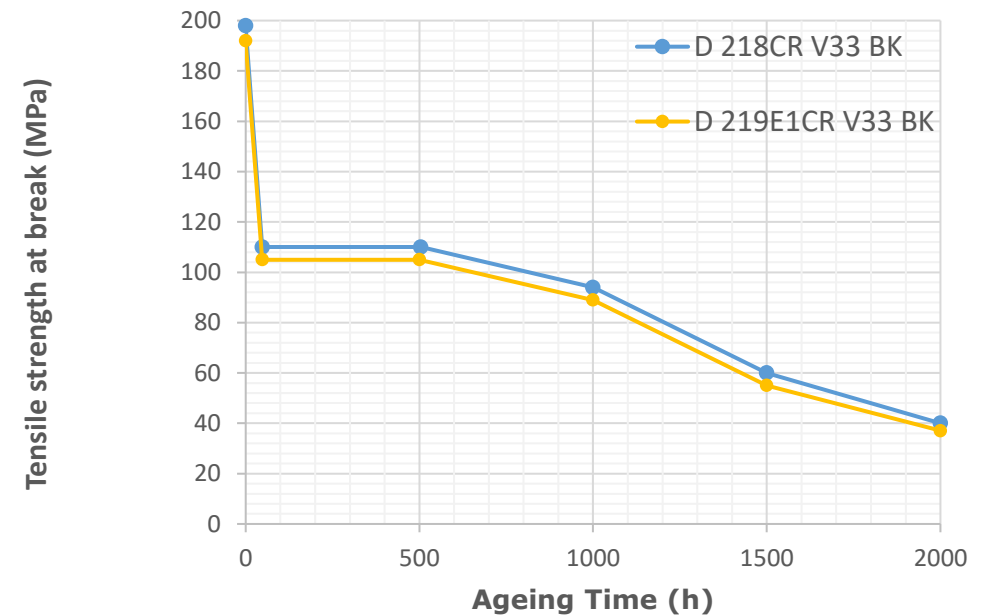
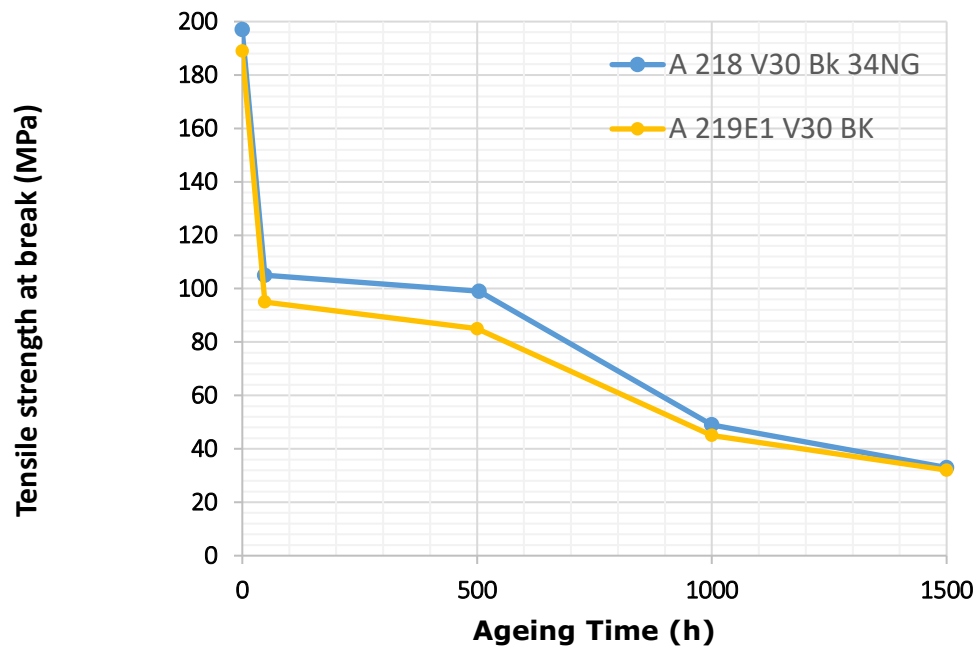


TECHNYL[®] PURE

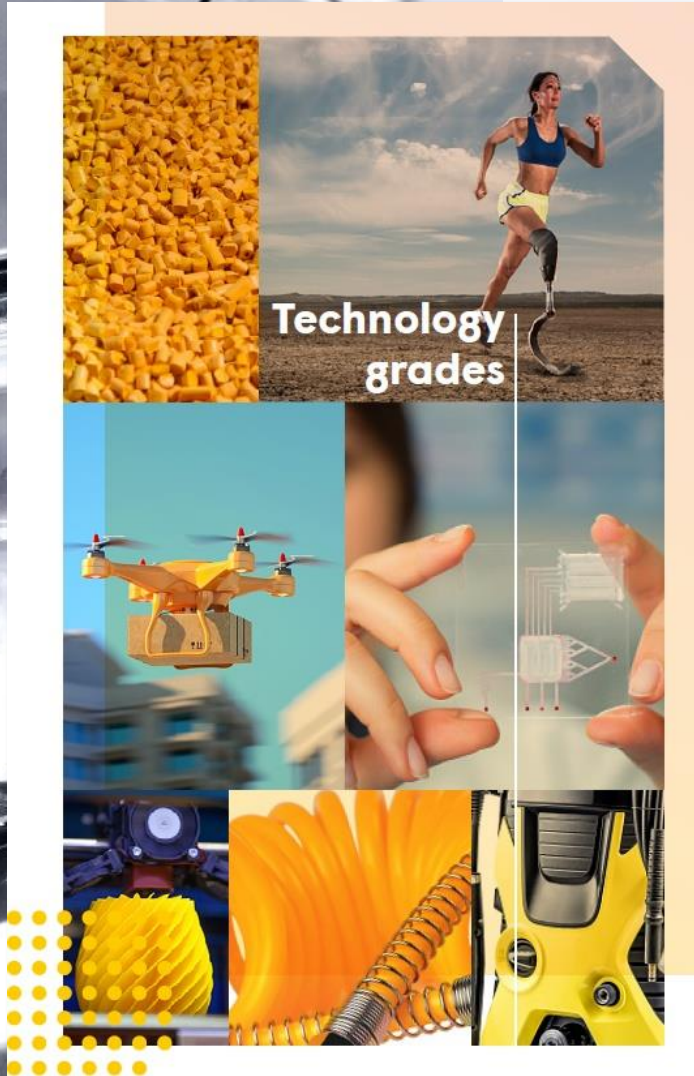
A 219E1 V30 BK

D 219E1CR V33 BK


Solution for SENSORS/CONNECTORS in **Cooling systems**
with **Similar hydrolysis resistance** as standard version



Ageing in Water/DSC Freecor Coolant (50/50) at 130°C



TECHNYL[®] PURE

 ... **not just a clean formula** (industrial, gmp, asset...)

 ... **a security insurance** for customers

 ... developed for **priority applications** (fuel cells, sensors,...)

 ... a driver towards **e-mobility**

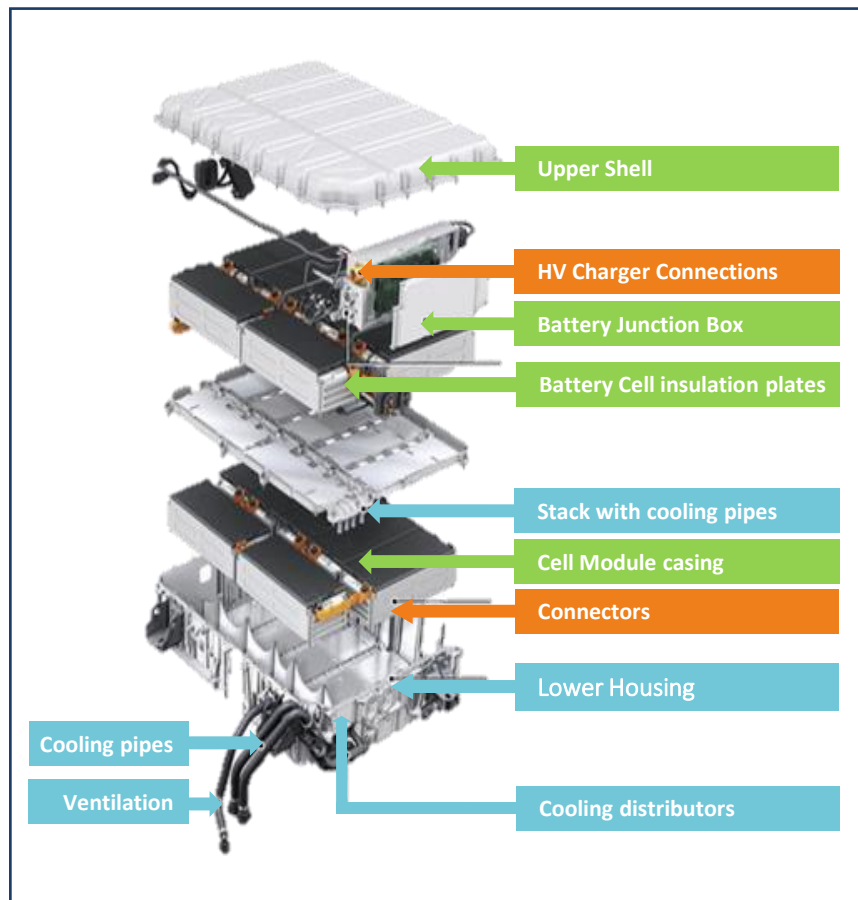


- E-safety: Corrosion & TECHNYL® PURE
- E-safety: Orange & TECHNYL®
- DOMO HFFR core competency to support AUTO
- Optimized TECHNYL® HFFR for thicker wall parts
- Cooling safety: Glycol & TECHNYL® HFFR
- Conclusions



E-MOBILITY IS A **TECHNYL**® PLAYGROUND

DOMO solutions for E-Mobility applications & challenges



HIGH VOLTAGE APPLICATIONS

KEYWORDS:

- ORANGE
- WORKING TEMPERATURE
- COLOR RETENTION
- PROCESSABILITY
- HFFR MATERIALS



MECHANICAL PARTS WITHIN BATTERY & HV CIRCUITS

KEYWORDS:

- UL 94 V0 (1,6 TO 3,2 MM)
- MECHANICAL PERFORMANCES
- PROCESSABILITY
- HFFR MATERIALS

COOLING MANAGEMENT

KEYWORDS:

- UL 94 V0
- GLYCOL MEDIA
- PROPERTIES RETENTION
- HFFR MATERIALS
- PARTNERSHIP DOMO/CLARIANT

HIGH VOLTAGE APPLICATIONS

ORANGE: AN E-MOBILITY MARKER**BLACK COLOR**

- ▶ For historical Polyamide **ICE** applications
- ▶ For new electrical applications on **EV's**
- ▶ For **low voltages** < 60V (DC) or 30V (AC)

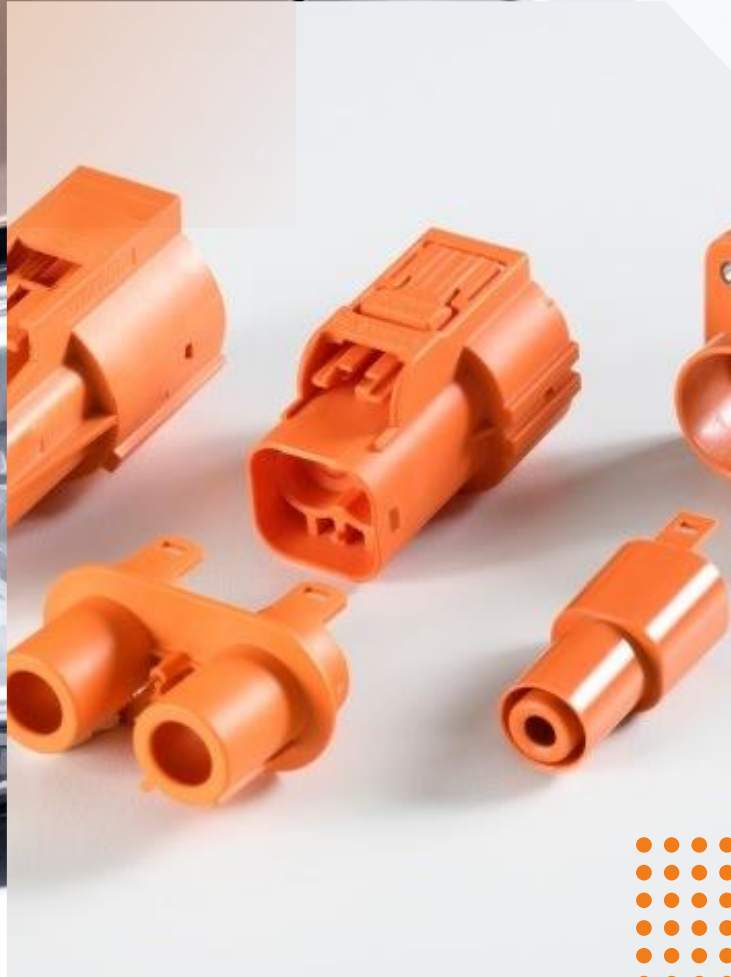
**ORANGE COLOR**

- ▶ For new electrical applications on **EV's**
- ▶ For **high voltages** > 60V (DC) or 30V (AC)
- ▶ For HV connectors, bus bars, relays,....



TECHNYL® ORANGE: OUR AMBITION

TECHNYL® ORANGE is meant to provide
SELF-COLORED POLYAMIDE SOLUTIONS
whatever **ORANGE RAL** need
that could showcase benefits in
COLOR STABILITY



HIGH VOLTAGE APPLICATIONS

TECHNYL® ORANGE: OUR POLYAMIDE TOOLBOX

 POLYAMIDE**PA 6****PA 66****High T°C** COLORS**RAL 2003****RAL 2008****RAL 2011** ADDITIVES**Halogen Free
Flame Retardant****NON
Flame Retardant** BENEFITS**1. Color stabilization****2. Processability****3. Laser-Marking**

HIGH VOLTAGE APPLICATIONS

TECHNYL® ORANGE: OUR SOLUTIONS PROVIDER

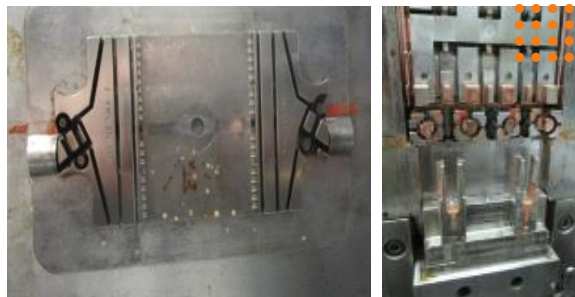
1 Color stability under ageing

- **110°C** (1000 h)
- **130°C** (1000 h)
- **> 130°C** (1000 h)



2 Deposit issues

- Pigments mold deposit
- Additives mold deposit
- Exudation



3 Laser-Marking

- **UV** (355 nm)
- **Visible** (532 nm)
- **IR** (1064 nm)



HIGH VOLTAGE APPLICATIONS

TECHNYL® ORANGE: OUR COLOR STABILITY TARGET**OEM NORM**
(VW 50314)

- Start: **Close RAL 2003**
- Temperature: **90°C**
- Duration: **1000h**

**COLOR VARIATIONS ALLOWED****RAL 2004**dE94 = **11,5****RAL 2008**dE94 = **3,0****RAL 2009**dE94 = **11,2****RAL 2011**dE94 = **2,2**

- ▶ For duration of **1000 hrs.**
- ▶ For temperature above 90°C
- ▶ Targeted: **110°C, 130°C, > 130°C**
- ▶ Whatever Polyamide grade

HIGH VOLTAGE APPLICATIONS

TECHNYL® ORANGE: OUR SOLUTIONS OFFER

We have developed
& ranked
our **orange range**
for **ageing**

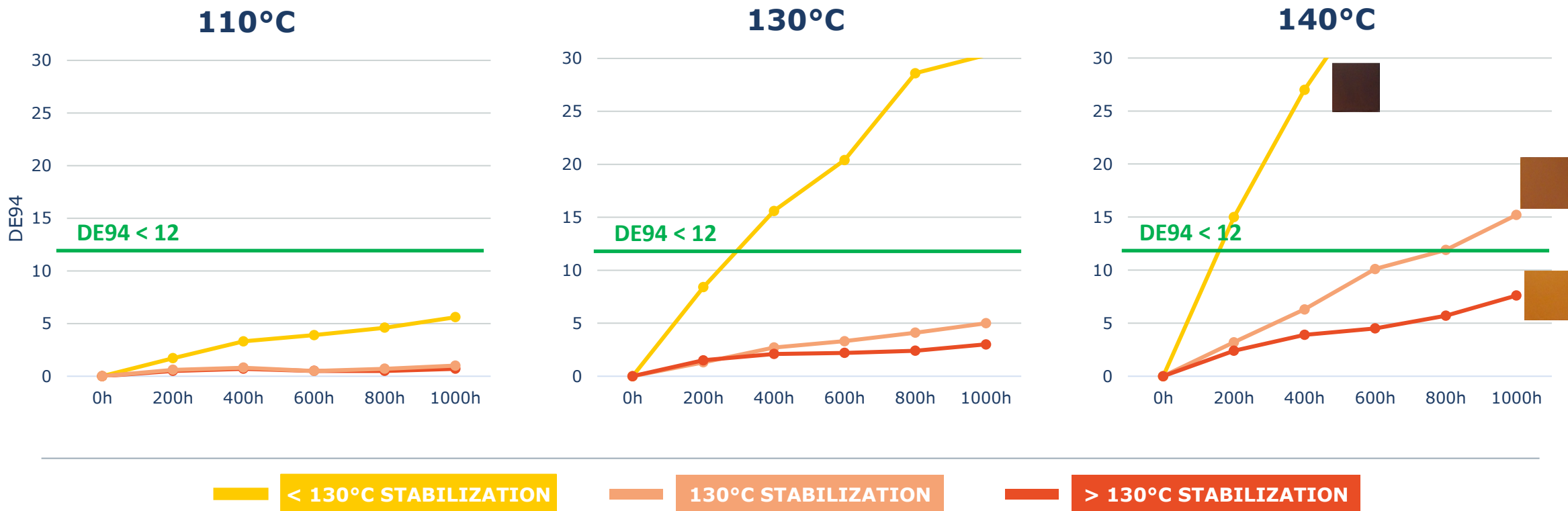


HIGH VOLTAGE APPLICATIONS

TECHNYL® ORANGE: COLOR RETENTION

Stabilization packages developed for **TECHNYL® ORANGE** showcase benefits when targeting right T°C of use

Ageing for 1000 hrs (PA 66 / 30% Glass filled / **ORANGE**)

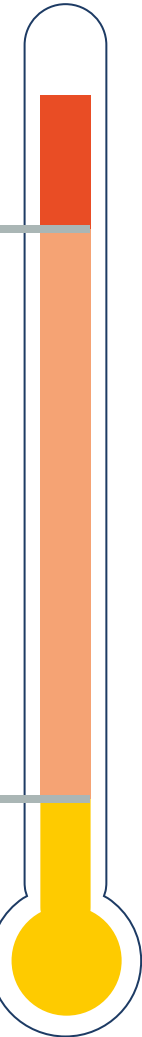


HIGH VOLTAGE APPLICATIONS

TECHNYL® ORANGE: OUR TODAY PRODUCTS OFFER

ORANGE STABILITY
DE94 < 12 (1000h)

 HFFR	TECHNYL® STAR 	S 60X1 V30 Orange 2720 also named "XS 1969"	> 130°C
	TECHNYL® STAR 	AF 60SX V30 Orange 2703 also named "XA 1573"	130°C
	TECHNYL® ONE 	J 60X1 V30 Orange 2701 also named "XHT 1721"	130°C
	TECHNYL® PROTECT 	C 50H2 Orange 2704 also named "XC 1734"	130°C
 No FR	TECHNYL®	A 219 V30 Orange 2702 also named "XA 1722"	130°C
	TECHNYL®	C 216 V30 Orange 2720 also named "XC 1801"	110°C



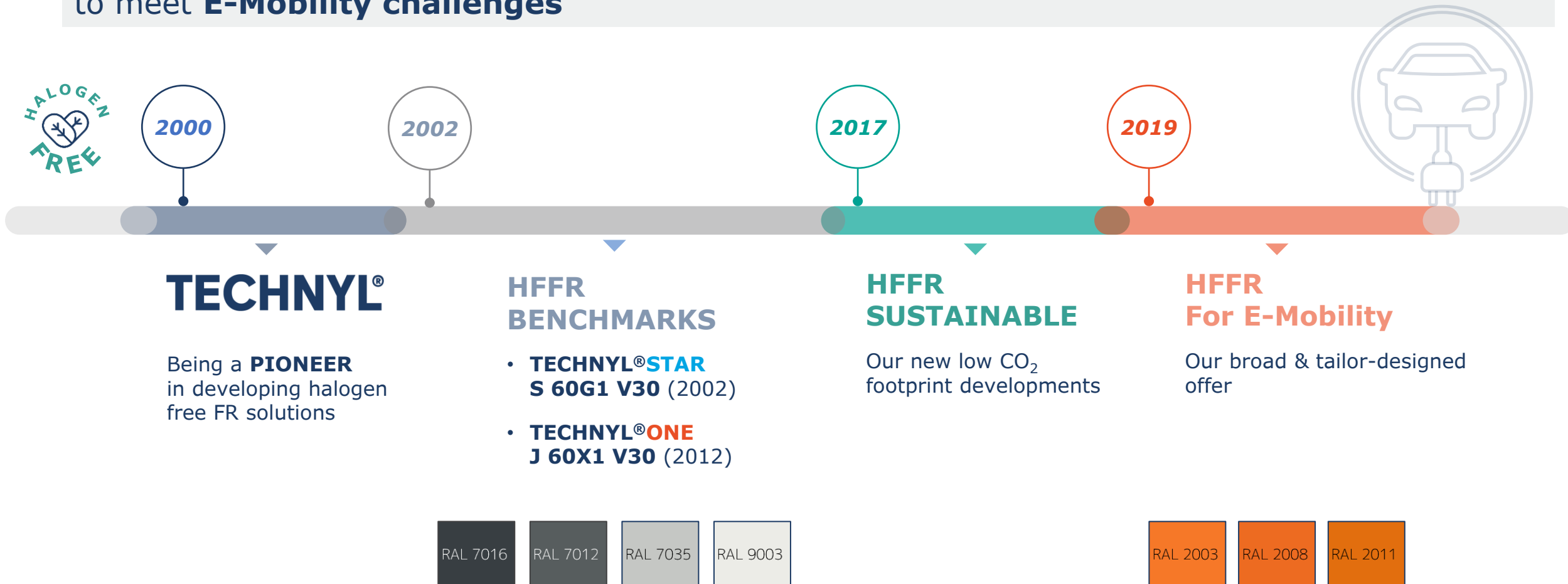


- E-safety: Corrosion & TECHNYL® PURE
- E-safety: Orange & TECHNYL®
- **DOMO HFFR core competency to support AUTO**
- Optimized TECHNYL® HFFR for thicker wall parts
- Cooling safety: Glycol & TECHNYL® HFFR
- Conclusions



TECHNYL® : BACKED BY OUR HFFR* DNA

DOMO is leveraging its DNA & expertise in **halogen free flame retardants** (*HFFR) to meet **E-Mobility challenges**



Leveraging **our expertise** in

flame-retardant

automotive



Connectivity

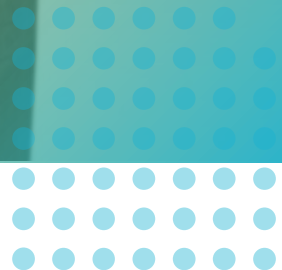


Vehicle
electrification

to bring a **customized range of HFFR-grades** designed for **E-mobility applications**

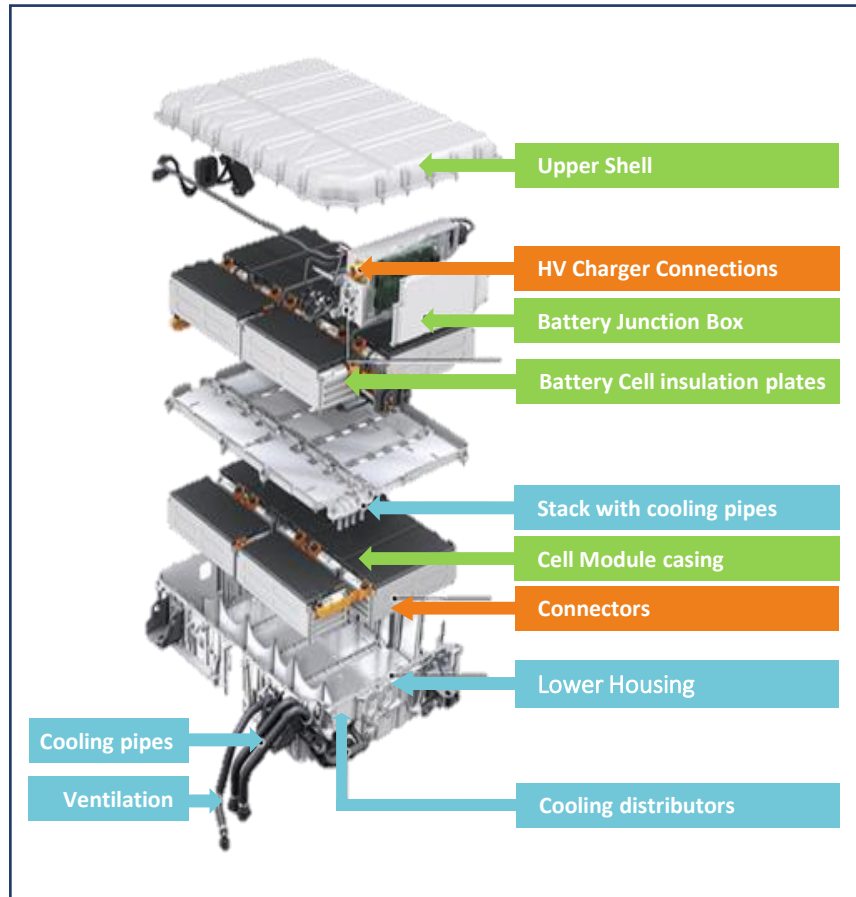


- E-safety: Corrosion & TECHNYL® PURE
- E-safety: Orange & TECHNYL®
- DOMO HFFR core competency to support AUTO
- **Optimized TECHNYL® HFFR for thicker wall parts**
- Cooling safety: Glycol & TECHNYL® HFFR
- Conclusions



E-MOBILITY IS A **TECHNYL**® PLAYGROUND

DOMO solutions for E-Mobility applications & challenges



MECHANICAL PARTS WITHIN BATTERY & HV CIRCUITS

KEYWORDS:

- UL 94 V0 (1,6 TO 3,2 MM)
- MECHANICAL PERFORMANCES
- PROCESSABILITY
- HFFR MATERIALS



A2MAC1 Copyright A2Mac1



HIGH VOLTAGE APPLICATIONS

KEYWORDS:

- ORANGE
- WORKING TEMPERATURE
- COLOR RETENTION
- PROCESSABILITY
- HFFR MATERIALS

COOLING MANAGEMENT

KEYWORDS:

- UL 94 V0
- GLYCOL MEDIA
- PROPERTIES RETENTION
- HFFR MATERIALS
- PARTNERSHIP
DOMO/CLARIANT



THE TECHNYL RANGE

FOR AUTOMOTIVE
FLAME-RETARDANT NEEDS
combined with
our HIGH-FLOW technology

U L - 9 4 V 0 - T H I C K N E S S



TECHNYL® STAR

S 61X1 V30-50 BK



TECHNYL® STAR

AF 60SX V30 BK
S 60X1 V30 BK



TECHNYL® ONE

J 60X1 V30 BK

Optimum Electrical Performance
combined with good flowability
UL-94 V0 @ 0.4mm
PA high Temperature



THE TECHNYL RANGE

FOR AUTOMOTIVE
FLAME-RETARDANT NEEDS
combined with
our HIGH-FLOW technology

U L - 9 4 V 0 - T H I C K N E S S



TECHNYL® STAR 
S 61X1 V30-50 BK



TECHNYL® STAR 
AF 60SX V30 BK
S 60X1 V30 BK

TECHNYL® ONE 
J 60X1 V30 BK

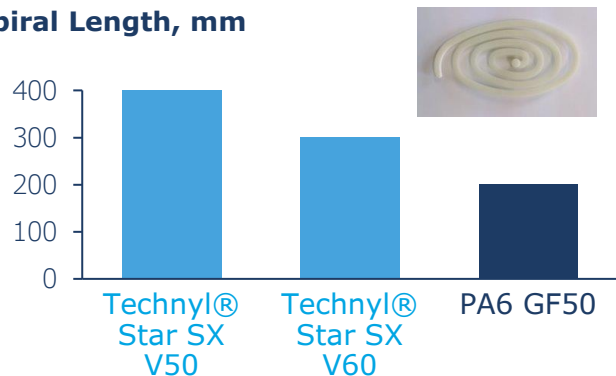
Optimum Electrical Performance
combined with good flowability
UL-94 V0 @ 0.4mm
PA high Temperature

MECHANICAL PARTS WITHIN BATTERY & HV CIRCUITS

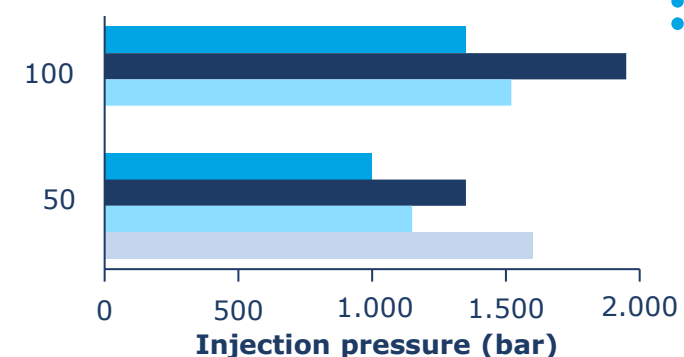
TECHNYL® STAR

EXCELLENT FLOWABILITY WITHOUT COMPROMISING ON PERFORMANCE

Spiral Length, mm



Cavity Filling (%)



■ Technyl® Star SX GF50 ■ Technyl® Star SX GF60
■ PA6 GF50 ■ PA6 GF60

Exceptional flow characteristics during injection

Up to **60%** more flowability than standard PA 6,6*

Up to **100%** more flowability than standard PA 6*

**at equivalent polymer matrix and filler level*

Wider processing window & less scrap

Fewer injection points and smaller runners

Higher part yield

Greater Design Flexibility

Lower barrel pressure and temperature

Excellent surface quality

TECHNYL® STAR
AFX 218 V60



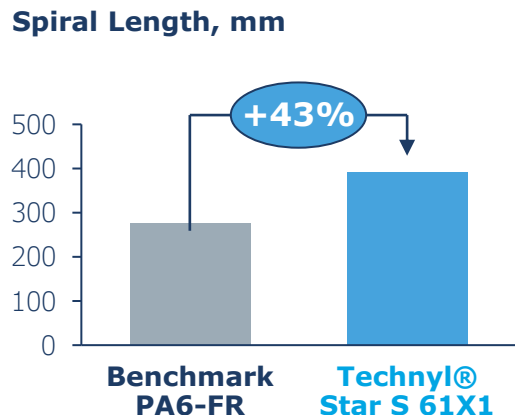
Standard
PA66+GF60

MECHANICAL PARTS WITHIN BATTERY & HV CIRCUITS

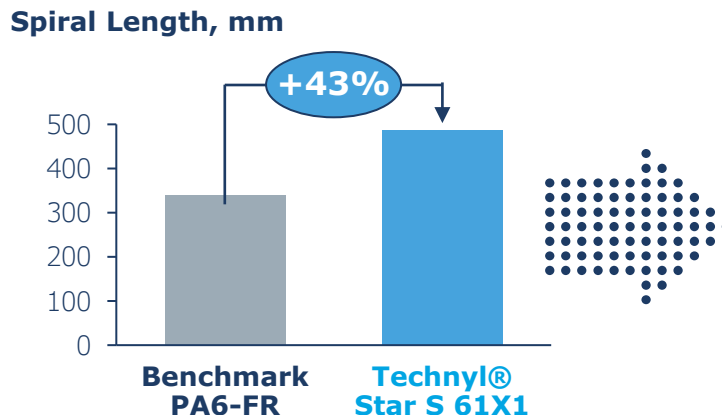
TECHNYL® STAR S 61X1 V30 BK – FLAME-RETARDANT - AUTO

Outperforming PA6 market benchmark at 20°C lower barrels Temperature

I SPIRAL TEST AT 240°C

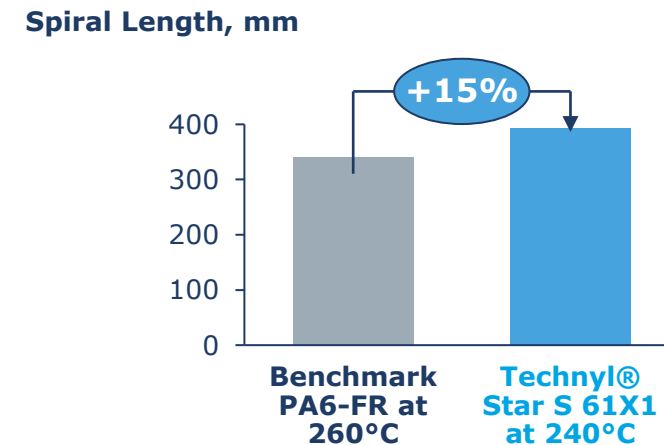


I SPIRAL TEST AT 260°C



TECHNYL® STAR S 61X1 V30 BK

I 15% LONGER SPIRAL AT -20°C LOWER BARREL T°C



- 1 Improved cycle time: energy and cost saving
- 2 Less degradation of the additive

- 3 Greater design flexibility
- 4 Excellent surface quality

MECHANICAL PARTS WITHIN BATTERY & HV CIRCUITS

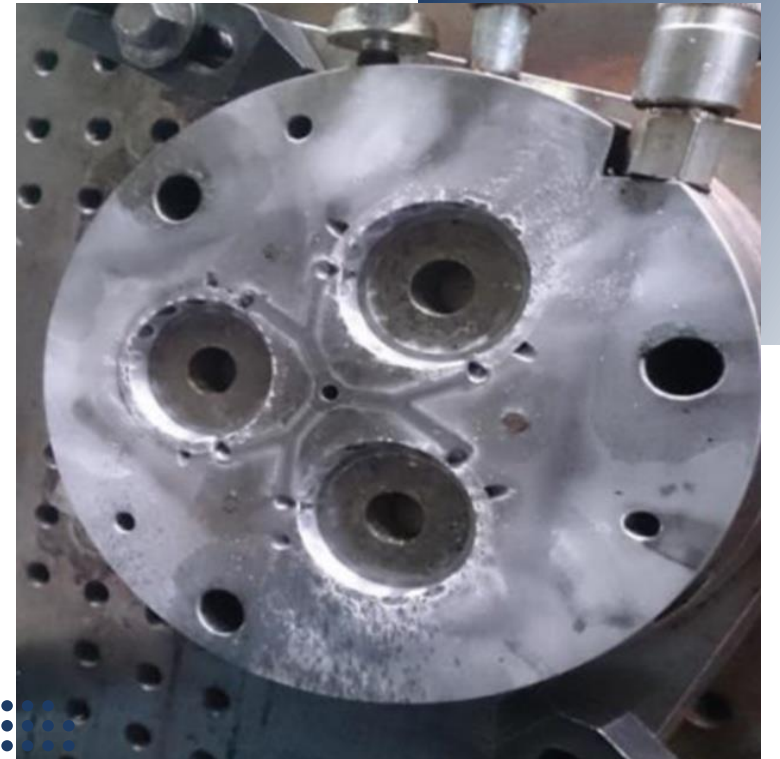
TECHNYL® STAR FR - AUTO

FR grades require **specific attention** when being **processed**

TECHNYL® HFFR RANGE

for **AUTOMOTIVE** enables :

- > **less** mold deposit
- > **less** tool corrosion





TECHNYL[®] STAR

FR - AUTO

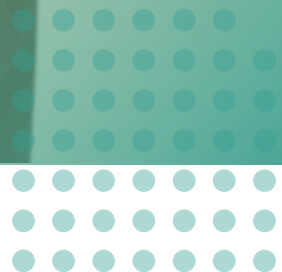
- Upcoming new grade **UL94 V0 @2.5mm**
- Domo expertise to support ***customization needs***



Reach out to our experts to develop your next **high-flow FR-grades for E-mobility** applications

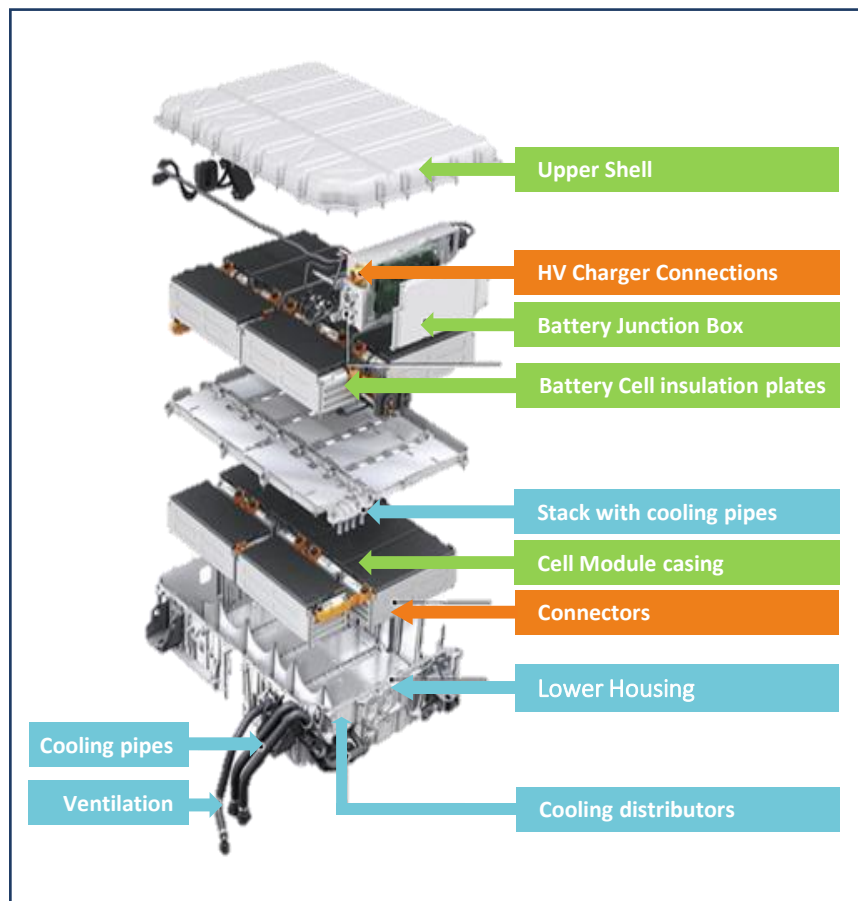


- E-safety: Corrosion & TECHNYL® PURE
- E-safety: Orange & TECHNYL®
- DOMO HFFR core competency to support AUTO
- Optimized TECHNYL® HFFR for thicker wall parts
- **Cooling safety: Glycol & TECHNYL® HFFR**
- Conclusions



E-MOBILITY IS A **TECHNYL**® PLAYGROUND

DOMO solutions for E-Mobility applications & challenges



COOLING MANAGEMENT

KEYWORDS:

- UL 94 V0
- GLYCOL MEDIA
- PROPERTIES RETENTION
- HFFR MATERIALS
- PARTNERSHIP
DOMO/CLARIANT



HIGH VOLTAGE APPLICATIONS

KEYWORDS:

- ORANGE
- WORKING TEMPERATURE
- COLOR RETENTION
- PROCESSABILITY
- HFFR MATERIALS

MECHANICAL PARTS WITHIN BATTERY & HV CIRCUITS

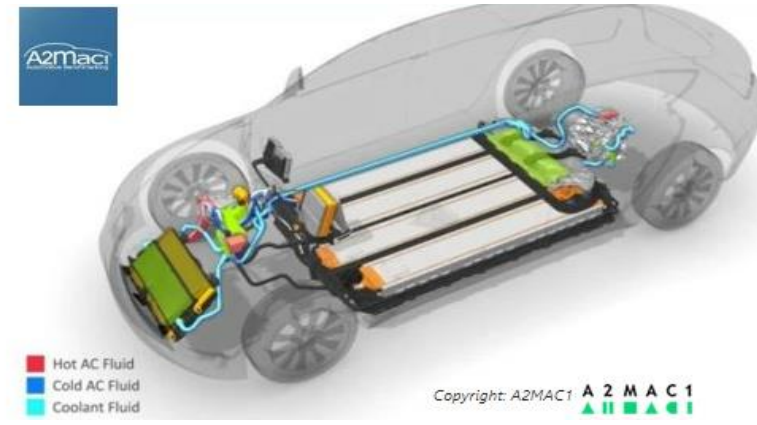
KEYWORDS:

- UL 94 V0 (1,6 TO 3,2 MM)
- MECHANICAL PERFORMANCES
- PROCESSABILITY
- HFFR MATERIALS

COOLING MANAGEMENT

MARKET EVOLUTION FOR COOLING CIRCUIT
BETWEEN ICE & E-MOBILITYCOOLING CIRCUIT FOR **ICE**

- **One glycol loop**
- Conditions for plastics: **2000 to 3000h / 120 to 140°C**
- Flame-retardancy: **Not a requirement**
- TECHNYL offer: **Seen as market references**

COOLING CIRCUIT FOR **xEV**

- **Several glycol loops** (Battery, power electronics,...)
- Temperature of usage extends to **lower values** (down to 80°C)
- Flame-retardancy: **Becoming a requirement ?**
- TECHNYL offer: **HFFR products under study**

COOLING MANAGEMENT

COMBINATION OF STRENGTHS PARTNERSHIP DOMO-CLARIANT

DOMO

Reliable partner

& worldwide leader in

non FR glycol resistant grades.

PA 66 SOLUTIONS

A 218 V30 Black 34NG:

- ✓ HR Market reference
- ✓ Up to 3000h / 120°C

A 218 G2 Black 34 N:

- ✓ HR Best in class PA66
- ✓ + 30% life extension

PA 6.10 SOLUTIONS

D 218CR V33 Black:

- ✓ Excellent processability
- ✓ Up to 1000h / 135°C

D 219 V50 Black:

- ✓ For >2000h / 130°C

NEW PA 6 SOLUTION

C 218 V30 Black 21N

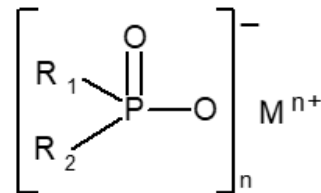
- ✓ Up to 10000h / 80°C



CLARIANT

**A worldwide leader in
halogen-free flame-retardant
products**

**Exolit® OP
phosphinates**



- Clariant has invented Exolit® OP Flame-Retardants and has a strong, global patent position on substances, formulations, production processes and applications for these.
- Exolit® OP phosphinates are produced in two world class plants in Knapsack (Germany)
- Exolit® OP products are recognized by third parties as one of the most sustainable Flame-Retardant solutions.
- In 2021, Clariant announced the construction of a new plant in Dayabai (China) that will be on stream in 2023

DOMO

COOLING MANAGEMENT

COMPARATIVE EVOLUTION OF AGEING REQUIREMENTS FOR COOLING CIRCUITS BETWEEN ICE & EV



COOLING MANAGEMENT

DOMO – CLARIANT PARTNERSHIP FOR HFFR BENCHMARK SCREENING STUDY TO BUILD PERFORMANCES BASE-LINE UNDER GLYCOL AGEING

1. STUDY SCOPE



- Model conditions
- First (& fast) screening
- Discrimination by performances level (UL 94,..)
- Behavior understanding by analyses

2. EXPERIMENT CONDITIONS



- Temperature of glycol solution: **85°C**
- Ageing duration: **1000h**
- Coolant type: **Ethylene glycol / water (50/50v)**



3. EXPERIMENT MATERIALS



- Polymers studied: PA 6, PA 6.10, PPA, **PA 66**
- FR systems: **HFFR additives** from Clariant
- Reinforcement: **30% glass filled**

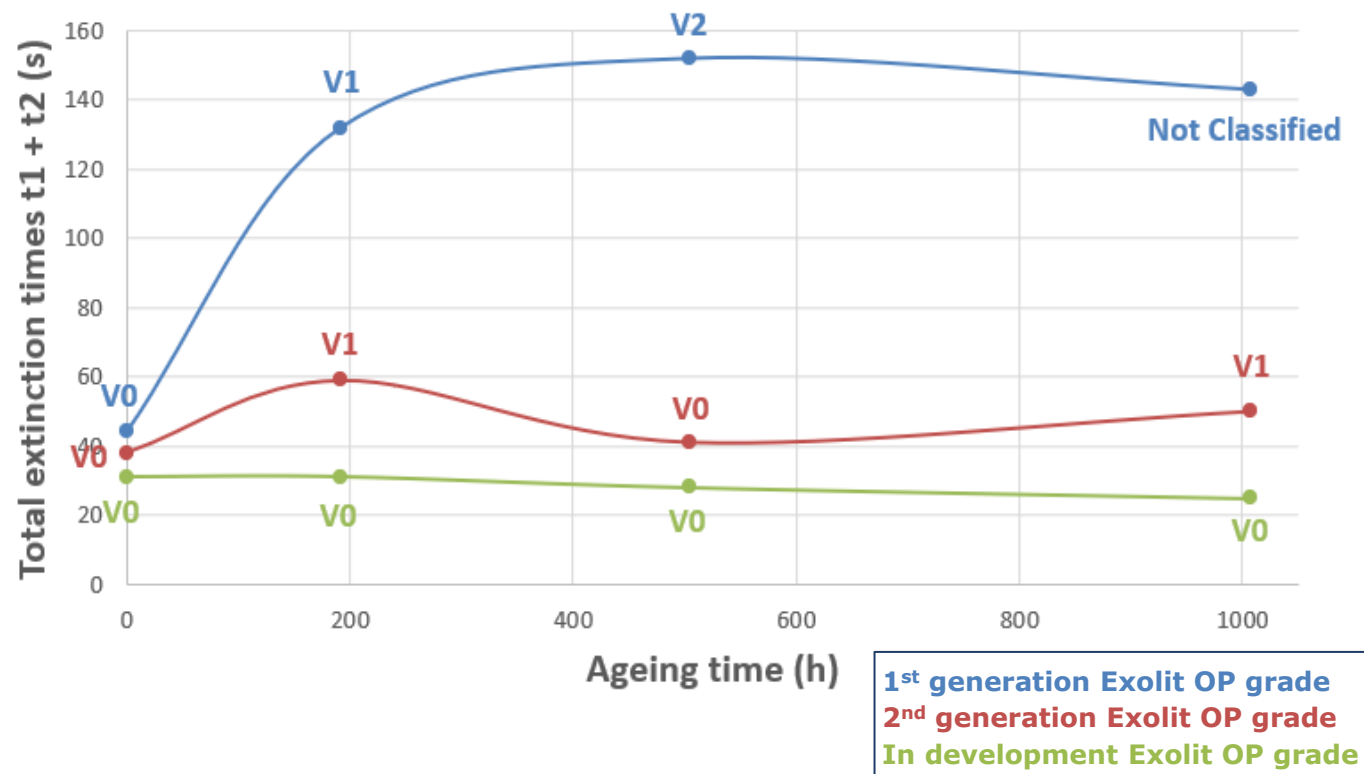
COOLING MANAGEMENT

UL 94 RETENTION DURING COOLANT AGEING

COMPARISON BETWEEN DIFFERENT EXOLIT GRADES

CONDITIONS:

85°C / 0.8 MM THICKNESS / PA 66 + HFFR + 30% GLASS



UL 94 @0.8 mm rating retention improved with HFFR generations

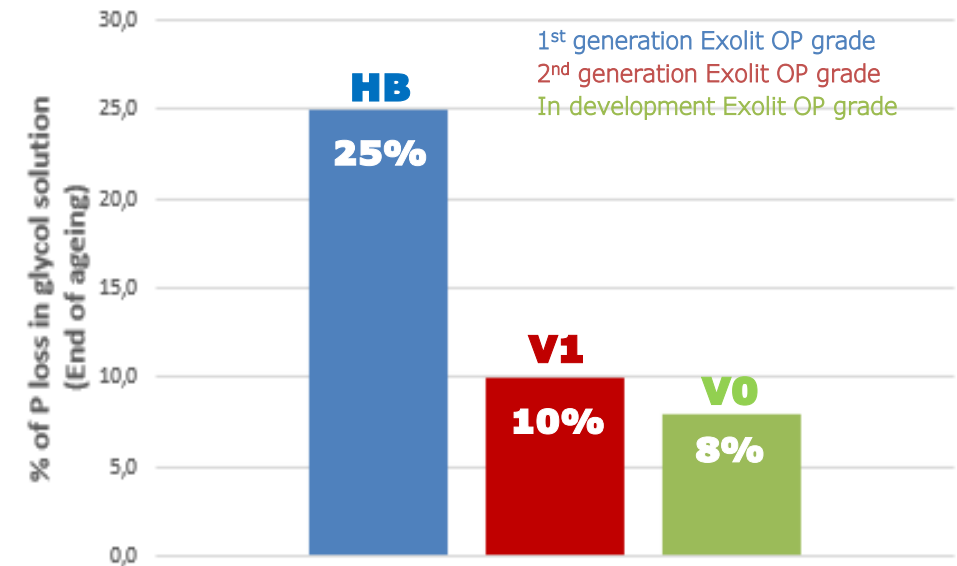
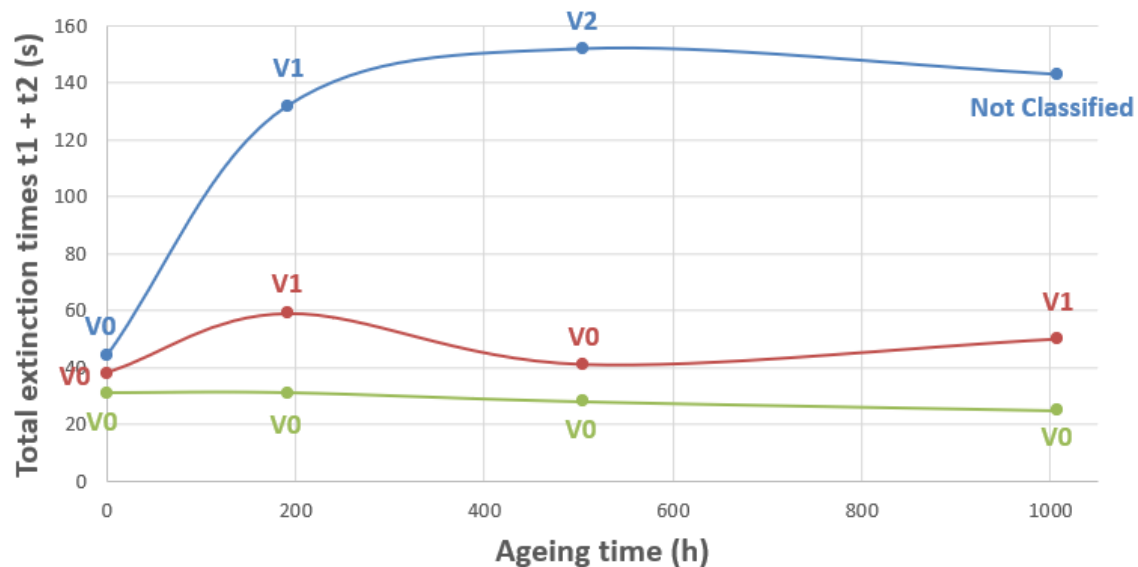
- **1st generation** not suitable
- **2nd generation** for parts > 0.8mm
- **Development grade** having shortest extinction times

COOLING MANAGEMENT

FR BEHAVIOR UNDERSTANDING DURING COOLANT AGEING

COMPARISON BETWEEN DIFFERENT EXOLIT GRADES

LOSS OF PHOSPHORUS SPECIES EVOLUTION: **85°C / PA 66 + HFFR + 30% GLASS / 0.8 MM THICKNESS**



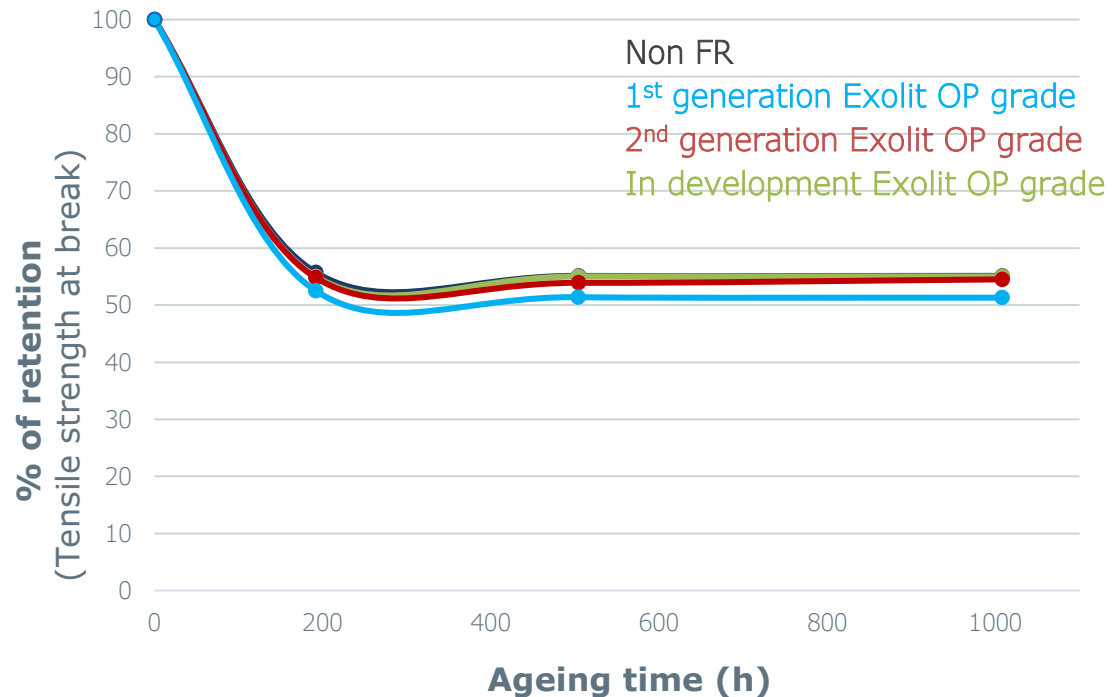
- **25% of Phosphorus loss for 1st generation** grade mainly due to HFFR synergist
- **Good performances retention with 2nd generation & development grade** thanks to lower quantity of P-species leached

COOLING MANAGEMENT

MECHANICAL RETENTION DURING COOLANT AGEING

COMPARISON BETWEEN FR & NON-FR GRADES

CONDITIONS: **85°C / PA 66 + 30% GLASS**



- **No visible degradation** for HFFR grades
- **Similar trend** for non-FR & HFFR grades
- **Only 1st generation** slightly impacted
- **Similar loss in molecular weights** for non-FR & HFFR grades

COOLING & HFFR MATERIALS

we are **READY!**

MAIN OUTCOMES

- ▶ **Together DOMO & CLARIANT are developing HFFR solutions** for cooling
- ▶ **By selecting right HFFR, UL 94 V0 rating is retained** in glycol
- ▶ **By modifying global formulation,** overall performances are further improved

Could be discussed:

- **Other ready-to-go solutions**
- **Other available results**
- **Further developments**



- **E-safety:** Corrosion & TECHNYL® PURE
- **E-safety:** Orange & TECHNYL®
- **DOMO HFFR core competency** to support AUTO
- **Optimized TECHNYL® HFFR** for thicker wall parts
- **Cooling safety:** Glycol & TECHNYL® HFFR
- **Conclusions**





SUSTAINABLE HFFR: ALREADY TODAY BUT NEXT...

is available for sampling

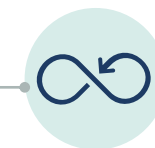


TECHNYL® 4EARTH 
Sustainable polyamide

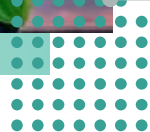
is supported by our **HFFR DNA**



has **positive CO₂ footprint**



is under **UL certification**



CONCLUSION



EXPERTISE



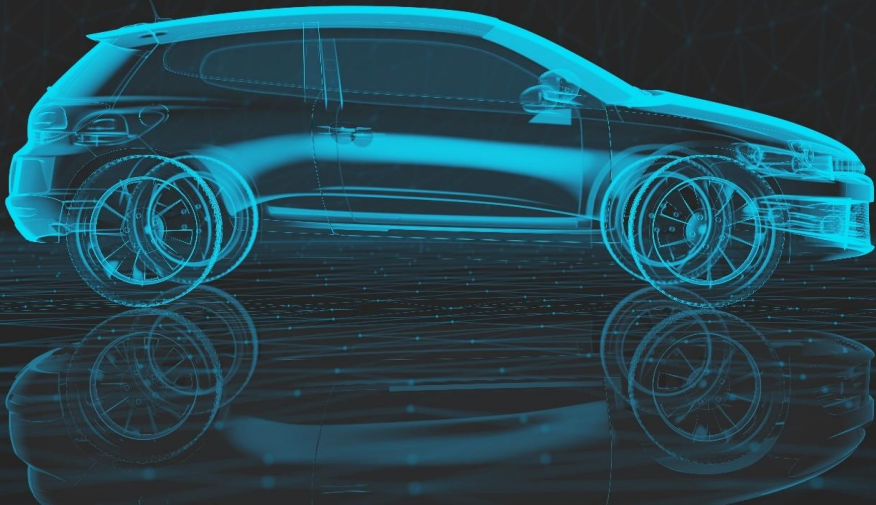
INNOVATION



AGILITY & CREATIVITY



KEY PARTNER



Domo is putting its core **competencies** in **fire protection**, thermal management,...as well as its **sustainability** values to offer & **tailor-design** materials for the **future mobility**

E-corrosion: TECHNYL® PURE offer available

Orange: TECHNYL® solutions available

Thick wall: TECHNYL® HFFR offer available & under dev.

Glycol: TECHNYL® HFFR offer available & under dev.



Still fast changing environment, we keep tuned,
keep connected with us !!!



DOMO

caring
is our formula

THANK YOU
FOR YOUR
ATTENTION

