

ACTILOX® HTB EX

Ceramifying mineral flame retardant blends

Halogen Free Mineral based flame-retardant blends with strong Heat Barrier properties

Flame Retardancy is a key material property required in infrastructure, mobility and E&E applications. There is clear trend toward non-toxic, lightweight and sustainable materials. In parallel, fire safety standards are increasing steadily, and, in many applications, they go far beyond "simple" ignitability criteria. Instead, wherever high fire protection requirements are necessary, the formation of a stable heat barrier under fire load is a must.

Nabaltec AG has developed the **ACTILOX® HTB EX** product category to fulfil these requirements.

ACTILOX® HTB EX is a group of halogen-free mineral-based flame-retardant filler blends which, together with the respective polymer matrix, form hard, ceramic-like layers in the event of a severe fire. The ceramic-like residues guarantee physical strength and strong heat protection.

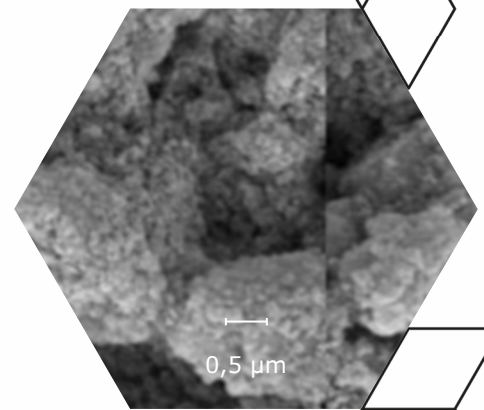
This series of products is currently still in development status (EX).

Product properties

- Mineral based filler blends
- Adjusted formulations according to
 - application and
 - polymer matrix
- Form hard ceramic-like barriers with
 - Heat & flame resistance
 - Abrasion & Particle resistance

Applications

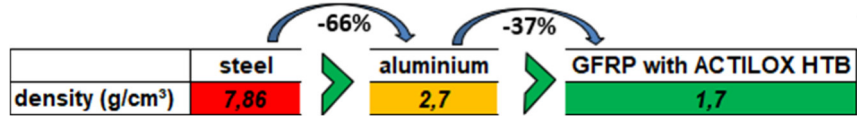
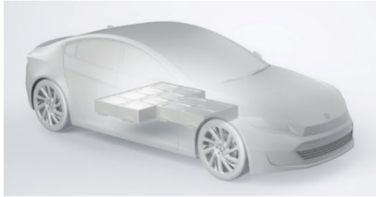
- Battery enclosures made of
 - GFRP (thermoplastics)
 - GFRP (thermosets), e.g. SMC/BMC, Prepregs
 - Organosheet-Composites
- Coatings used to protect
 - SMC (Gelcoats)
 - Wood, Concrete
 - Steel, Metals (also housings)
- Sealants & Elastomers used in
 - Transport applications
 - Construction
 - E&E



Battery Housings

➤ Thermoplastics

The traditional materials of choice for battery housings are steel or



aluminium, as well as composite materials made of aluminium and mica. Increasingly, thermoplastics and thermosets are also being considered as materials.

Thermoplastic materials or glass fibre reinforced thermoplastics (GFRP) not only have the great advantage of saving weight compared to aluminium but are also very easy to recycle and can be produced in short cycle time.

The fire resistance requirements go far beyond the familiar UL94-V0 classification known from E&E. In case of a **battery thermal runaway**, a heat and flame barrier is needed, which encloses the burning and bursting battery, protecting vehicle and occupants from spread of fire, allowing passengers to escape.



As a pioneer in e-mobility, China firstly defined safety criteria in GB 38031- 2020, which became mandatory standard in July 2021 and will be replaced in July 2026 by the new version GB 38031-2025 (known as “No Fire, No Explosion”). Further national and international standards are expected to adopt similar or even more severe requirements on passenger safety.

For material qualification several test regimes have been developed. The **torch and grit test** described within UL2596 test is one the best-known test procedures.

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The ceramic-like residues guarantee physical strength and strong heat protection for battery housings in the event of a thermal runaway. To ensure the best flame-retardant performance, several products have been developed for each of the most common polymer systems. This has resulted in the following products: **ACTILOX® HTB PP EX** for polypropylene, **ACTILOX® HTB PA EX** for polyamide 6 and **ACTILOX® HTB PBT EX** for polybutylene terephthalate:

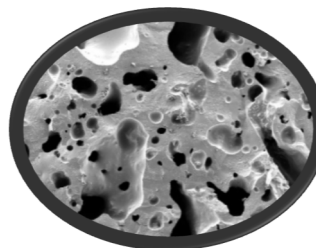
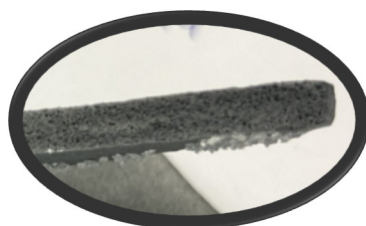
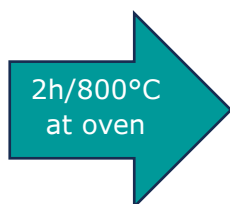
Product	Application	Processing
ACTILOX® HTB PP EX	Ceramifying filler for high temperature barrier in glass fiber reinforced PP or mineral fabric reinforced organosheet-composites.	<ul style="list-style-type: none"> • Good processability thanks to high bulk density. • High T-stability up to 260°C. • For injection moulding • For compression moulding of organosheet-composites
ACTILOX® HTB PA EX	Ceramifying filler for use as a heat barrier in fiber reinforced PA6 or PA6.6 formulations.	<ul style="list-style-type: none"> • Good processability thanks to high bulk density • High T-stability up to 320°C • For injection moulding

- Compounding on Noris Plastics ZSC 20/36 ($\varnothing = 20\text{mm}$; $L/D = 36$)
- Under Water Granulation on ECON EUP 10
- Injection moulding on Krauss Maffei 65-180 CX ClassiX ($\varnothing = 28\text{mm}$; max forward force 650 kN)

Formulation PA6-GF20	[wt.-%]		
PA6 (MAKAMID BV270 natur)	80	37,5	37,5
Tegomer E525 (Process aid)		2,5	2,5
Glass fibre	20	20	20
ACTILOX B60		40	
ACTILOX® HTB PA EXL			40

Compound Properties, PA6-GF20, 3mm specimen

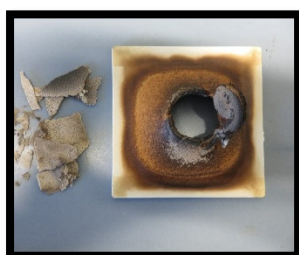
Mechanical properties	PA6 reference (20%GF)	40% ACTILOX B60 (20%GF)	40% ACTILOX HTB PA EXL (20%GF)
Tensile strength [MPa]	126,0	78,9	108,0
Elongation at Break [%]	5,1	2,6	1,6
E-Modulus [MPa]	6.600	8.120	11.200
impact strength charpy (kJ/m ²)	38	23	18
impact strength charpy notched (kJ/m ²)	5,2	2,6	5,2
3-point-bending strength after 2h/800°C [MPa]	0,0	0,0	7,4



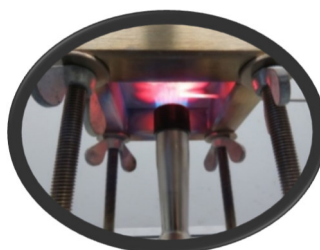
Compound with ACTILOX® HTB PA EXL after 2h incineration at 800°C

SEM image 40% ACTILOX® HTB PA EXL after 2h/800°C

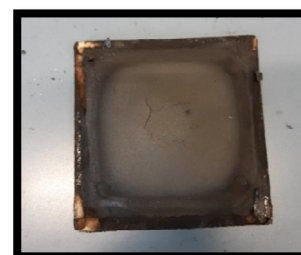
Compound filled with ACTILOX® HTB PA EXL shows a clearly ceramified structure after 2 hours at 800°C in oven.



40 wt.-% ACTILOX® B60:
Sample plate fails after 2 min at a load of 0.7 kPa and simultaneous flame treatment at 1000°C



Torch Flame Test: 1650W propane-butane burner applied for 20 min – surface temperature 1000°C



40 wt.-% ACTILOX® HTB PA EXL:
Sample withstands a load of 1.6 kPa with simultaneous flame treatment at 1000°C for more than 20 min without damage

Compound specimen after Torch Flame Test: right with ACTILOX® B60, left with ACTILOX® HTB PA EXL.

Flame retardant properties	PA6 reference (20%GF)	40% ACTILOX B60 (20%GF)	40% ACTILOX HTB PA EXL (20%GF)
MARHE [kW/m ²]	397	149	187
THR [MJ/m ²]	103	68	72
TSR [m ² /m ²]	337	284	230
GWIT 3mm [°C]	Not determined	750	825
CTI 3mm [V]	600	600	575

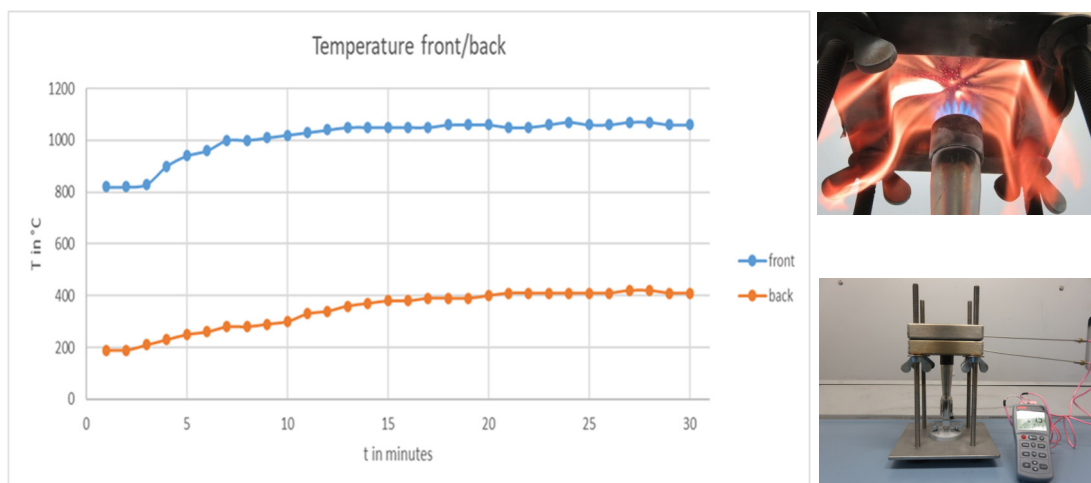
Flame Retardant Parameters measured by Cone Calorimetry (Heat-Flux: 50kW/m²), Glow-Wire-Ignition-Temperature (GWIT) and Comparative Tracking Index (CTI) of PA6 with 20% GF.

ACTILOX® HTB EX is optimized for heat barrier properties evaluated by torch flame test, but it also results in good heat-release properties and excellent smoke-release values. Glow-Wire-Ignition Temperature (GWIT) is very high!

➤ Thermosets

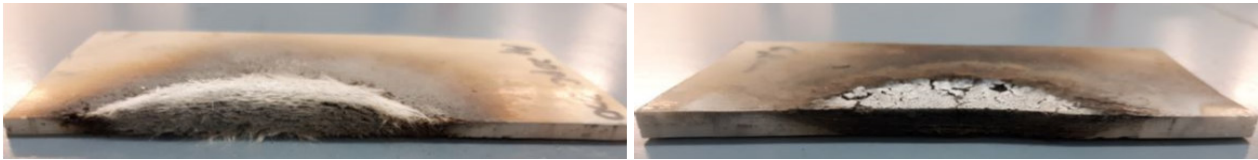
Product	Application	Processing
ACTILOX® HTB UP EX	Ceramifying filler for high temperature barrier in glass fiber reinforced or mineral fabric reinforced UP or EP-resins	<ul style="list-style-type: none"> • Easy dispersible with standard shear mixing equipment • T-stability up to 200°C. • For SMC, BMC, prepregs, • For compression moulding of organosheet-composites

Composites based on thermosets are well established materials in transportation applications. Lightweight constructions in public mass transport fulfilling highest fire safety standards are commonly made of ATH filled Sheet Moulding Compounds (SMC). When ATH filled SMC is used for battery enclosures, mica sheets are additionally applied in the space between battery module and the SMC lid. This requires an additional step during battery assembly. When using **ACTILOX® HTB EX** as flame retardant filler in SMC, no additional barrier sheet is needed. The ceramic layer forming during exposure to a torch flame (simulating the thermal runaway of battery cells), acts as an excellent barrier. To demonstrate this effect, the T-recording of a hand lay-up laminate exposed to a severe heat flux is shown below:



Temperature as a function of test duration during Torch Flame Test of a hand lay-up laminate with a 1650 W propane-butane burner applied for 20 min – in blue T at front side = exposed to flame, in orange T on back side. Temperature on back side stays < 400°C for 20 min and T-difference between front- and backside is > 600°C demonstrating the efficient heat barrier function of the ceramified composite!

The cross section of the specimens demonstrates ceramic like ceramic residue formed with **ACTILOX® EX HTB**:



300 phr APYRAL® 20X in UP, 15 wt.-% GF-mat:
soft ash residue with loose glass fibers

250 phr ACTILOX® HTB UP EX, 15 wt.-% GF-mat:
Stable ceramic residue, no blow-up, no fibers

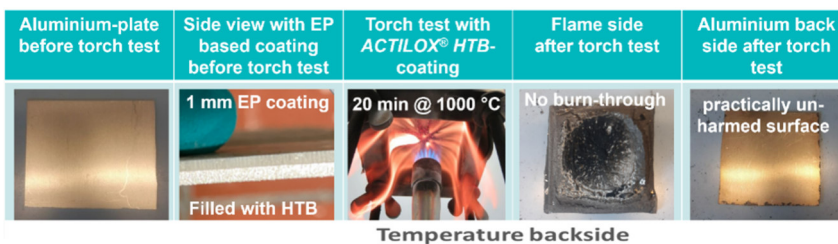
Residues of specimens after 30 min Torch Flame Test on a hand lay-up laminate.

➤ Coating of metal

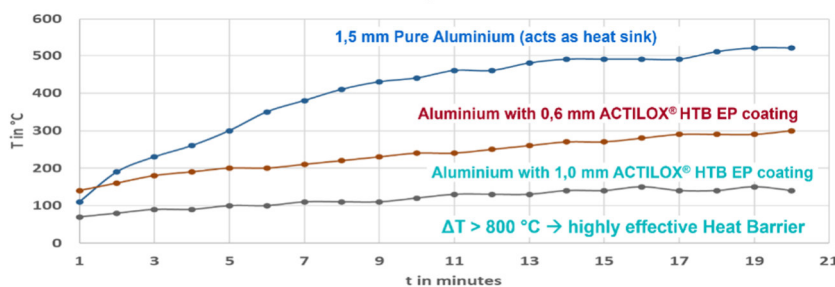
Product	Application	Processing
ACTILOX® HTB UP EX	Ceramifying filler for use as a heat barrier in coatings made of polar resins	<ul style="list-style-type: none"> • Easy dispersible with standard shear mixing equipment • T-stability up to 200°C. • For coating of steel, aluminium, SMC, concrete, wood • For water borne coatings (e.g. acrylic) • For gelcoats and solvent borne coatings

Battery casings are also made of aluminium or steel. With 2.7 g/cm³ aluminium has a much lower specific weight than steel (7.9 g/cm³). But due its low melting temperature of 660°C, aluminium cannot withstand a thermal runaway. It always needs a protective coating to pass a typical torch test scenario.

Also, thin steel-sheets need protective coatings to withstand severe fire resistance tests. **ACTILOX® HTB EX** can be used flame retardant filler in coatings applied on metal sheets. The torch-test result below demonstrates the performance of EP-resin filled with **ACTILOX® HTB EX** at different thicknesses applied on an aluminium-sheet:



EP-resin containing 200 phr of **ACTILOX® HTB EP EX at 1 mm thick-ness** is effectively shielding the Al-sheet from the heat of the torch-flame.



- ✓ No burn through of the sheet.
- ✓ The backside is practically unharmed!
- ✓ Temperature on backside stays <150°C

Sealants/ Gaskets/ Busbars/ Cables

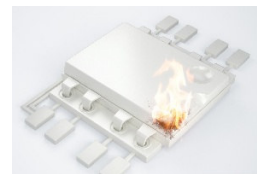
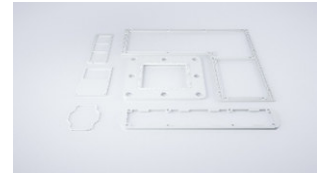
Flexible polymer materials for sealants, gaskets, tarpaulins or insulations/ sheathings for busbars or cables need to fulfil stringent regulatory requirements, very often including fire resistivity standards.

Aluminium hydroxide, especially fine precipitated grades of **APYRAL®** are excellent flame retardants and can fulfil most requirements. Nevertheless, there are stringent test regimes, which are hard to be fulfilled by **APYRAL®** alone.

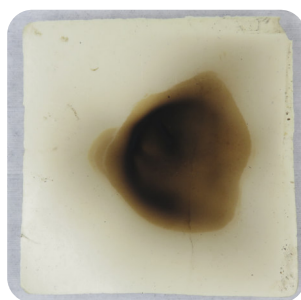
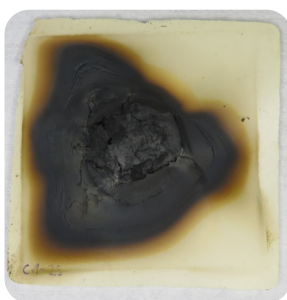
A requirement often found for gaskets/ sealants is the **Heat Gun or Hot Air Test**



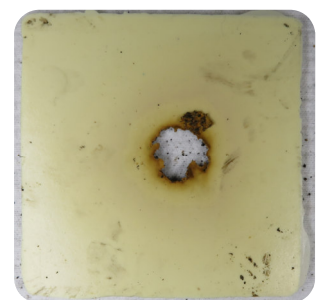
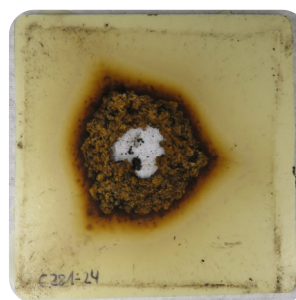
- 550°C hot air
- distance to specimen 2 cm
- specimen 10x10 cm², 3 mm thickness
- test duration 20 min
- goal: no burn-trough and ensure heat protection



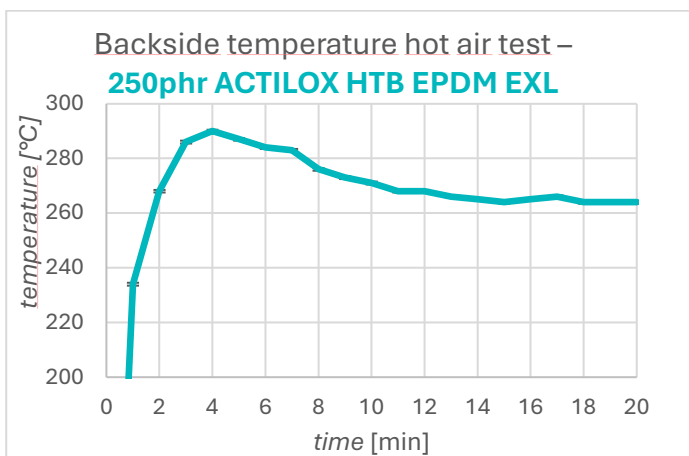
Components	EPDM	Process-aids		Process Oil	X-linking System					Filler
Products	Keltan 5470 C	Sasol-wax 5405	Ligacid SG3	Extens-oil 29	Vulkanox HS/LG	Zinkoxid actice	Kettlitz TAC-70XP	PERKA-DOX 14-EP40	VTMO	ATH or HTB
phr	100	1	0.5	40	1	5	1	5	2.5	250



Front (left) and backside (right) of a 250phr **ACTILOX® HTB EPDM EXL**
no burn trough within 20min



Front (left) and backside (right) of a 250phr **APYRAL® 40CD**
failed after 1:40 min



	250phr ACTILOX HTB EPDM EXL	250phr Ap 40CD
<i>Hot air test 500°C [min]</i>	>20	2
<i>LOI [%O2]</i>	30	29
<i>UL94V 1,6mm</i>	V0	failed
<i>Tensile strength [MPa]</i>	4,1	10
<i>Elongation at break [%]</i>	452	393

Product	Application	Processing
ACTILOX® HTB EPDM EXL	Ceramifying / barrier forming flame retardant filler for hot-air / hot-gun test	<ul style="list-style-type: none"> • Easy compoundable • T-stability up to 200°C. • For EPDM, TPE, • For compression moulding of organosheet-composites
ACTILOX® HTB SR EXL	Ceramifying filler for use as a heat barrier in silicone rubber applied in textile structures, cables, sealants, gaskets	<ul style="list-style-type: none"> • Easy dispersible with standard shear mixing equipment • T-stability up to 200°C. • For textile structures, sealants, gaskets produced by moulding or (extrusion-) lamination

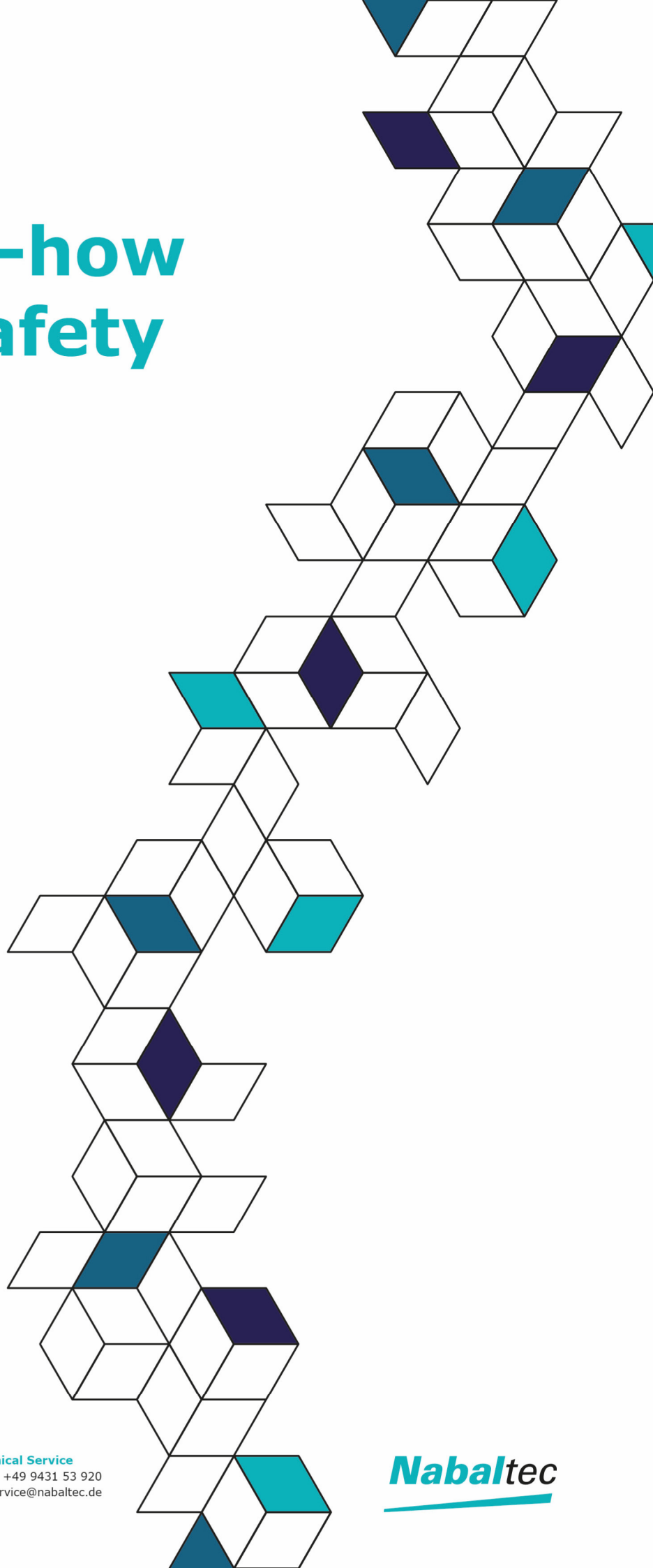
Product Overview by Application

Product	Resin / Matrix polymer applied	Application	Industries
ACTILOX® HTB PP EX	PP, HDPE	<ul style="list-style-type: none"> Injection Moulded GFRP, Organosheets 	Transport: battery covers Construction: Stationary battery enclosures; E&E-housings; conduits
ACTILOX® HTB PA EX	PA6, PA66, PPA	<ul style="list-style-type: none"> Injection Moulded GFRP, Organosheets 	Transport: battery covers Construction: Stationary battery enclosures; E&E-housings; conduits
ACTILOX® HTB PBT EX	PBT, PET	<ul style="list-style-type: none"> Injection Moulded GFRP, Organosheets 	Transport: battery covers Construction: Stationary battery enclosures; E&E-housings, conduits
ACTILOX® HTB UP EX	UP, EP	<ul style="list-style-type: none"> SMC, BMC, potting compounds 	Transport: battery covers, E&E-housings; Railway interior; Marine interior, Space & Aircraft
ACTILOX® HTB UP EX	EP, Acrylics, PVA	<ul style="list-style-type: none"> Coatings on <ul style="list-style-type: none"> o Metal o GFRP o Wood o Concrete 	Transport: battery covers made of Aluminium or Steel Construction: Steel protection, wood-protection, concrete, cable ducts
ACTILOX® HTB LSR EX	LSR (Liquid Silicone Resin)	<ul style="list-style-type: none"> Coatings <ul style="list-style-type: none"> o Textiles o Fiber mats 	Transport: truck-tarpaulins, gangway bellows, sealants, gaskets, heat barrier mats in batteries Construction: tarpaulins, sealants
ACTILOX® HTB SR EX	SR (Silicone Rubber)	<ul style="list-style-type: none"> Sealants, Gaskets, Insulation Compounds for Busbars, Cables 	Transport: truck-tarpaulins, gangway bellows, sealants, gaskets Construction: cable ducts, sealants, tarpaulins
ACTILOX® HTB EPDM EX	EPDM, EPR, NR	<ul style="list-style-type: none"> Sealants, Gaskets, Insulation Compounds for Busbars and Cables 	Transport: truck-tarpaulins, gangway bellows, sealants, gaskets, busbars Construction: cable ducts, sealants, tarpaulins
ACTILOX® HTB TPE EX	TPE, SEBS	<ul style="list-style-type: none"> Sealants, Gaskets, Insulation Compounds for Busbars and Cables 	Transport: sealants, gaskets, busbars Construction: cable ducts, sealants, tarpaulins

Product Overview – Powder Parameters

Product	D50 (µm)	D90 (µm)	BET (m ² /g)	Moisture (%)	Density (g/cm ³)
ACTILOX® HTB PP EXL	8	36	2.3	0.2	2.4
ACTILOX® HTB PA EXL	19	41	2.6	0.2	2.4
ACTILOX® HTB PBT EXL	20	42	2.6	0.2	2.2
ACTILOX® HTB UP EXL	13	40	1	0.1	2.4
ACTILOX® HTB LSR EXL	13	33	1	0.1	2.4
ACTILOX® HTB SR EXL	2	16	2.9	0.3	2.4
ACTILOX® HTB EPDM EXL	24	42	4.0	0.2	2.0
ACTILOX® HTB TPE EXL	7	40	8.4	0.4	2.7

Our know-how for your safety



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