New Performance and Safety Challenges for Plastics

ELECTRO MOBILITY

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Public

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Business Unit Additives
Flame Retardants
11.12.2018

what is precious to you?

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Why Electric Vehicles?

Reduction of reliance on fossil fuel → limited resources

Reduction of carbon dioxide emssions → less greenhouse gas emissions

Simpler technology: 200 parts in electric drive vs. 1200 parts in conventional combustion engine drive

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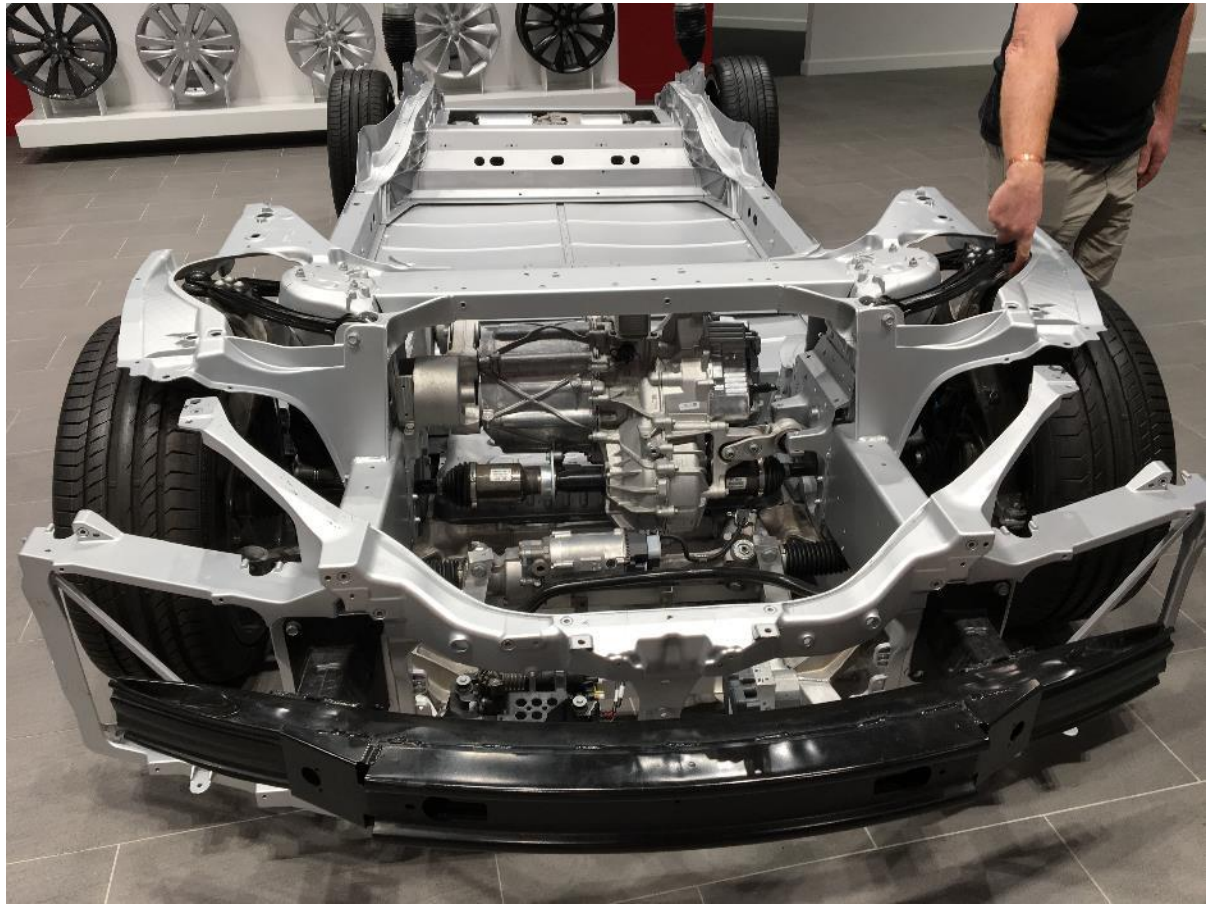
E-Vehicles – “simpler” technology also gives you more space …



Tesla Model S, photos: © A. Beard

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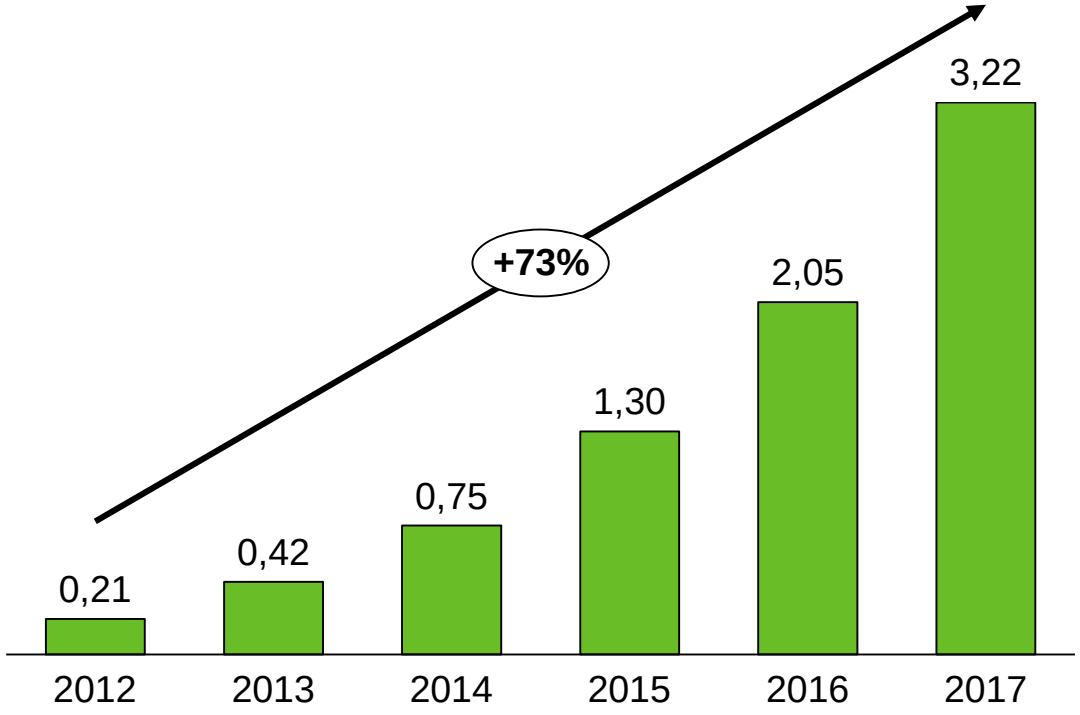
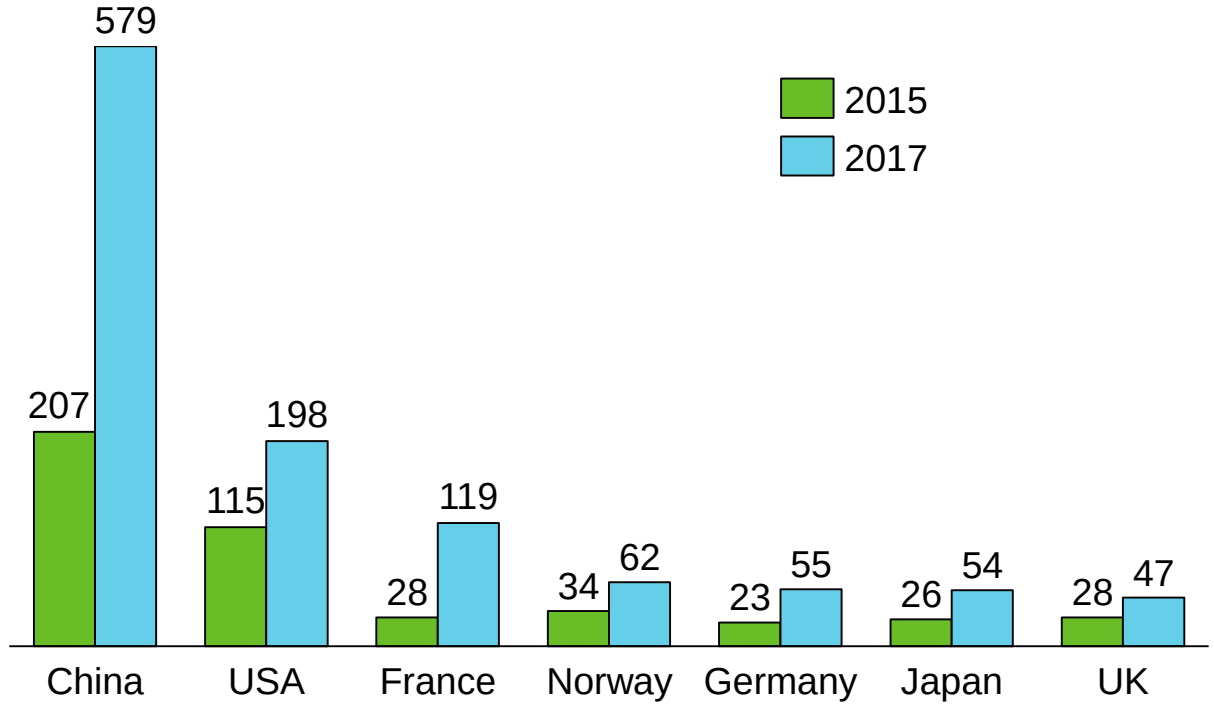
The total number of E-Vehicles has reached 3.2 mio units in 2017, forecasted at sales of 40 mio units by 2030 ~ 40% market share?

Number of electric cars (BEV + PHEV)
[million units]



BEV = battery electric vehicle,
PHEV = plug in hybrid electric vehicle

Sales of electric cars 2015 vs. 2017
[thousand units]



PLUS 7/2018, Page 1144
Source: International Energy Agency 6/18

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E-vehicles in China

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E-vehicles are entering the Mass Market

From premium …

– Tesla S, Audi e-tron, Jaguar I-Pace, Mercedes EQC

to mass market, existing …

– Renault Zoe 300 km and > 22 k€

– Nissan Leaf 350 km and 32 k€

– Opel Ampera 520 km and > 43 k€

Announced (Paris Motor Show 2018):

– Renault K-ZE (to start in China) 250 km and < 20 k€

– Kia E-Niro 485 km and ca. 30 k€

– Volkswagen I.D. Neo (end of 2019) 300 … 500 km and > 25 k€

– Until 2030, most e-cars with 500 km range will be more expensive than combustion engine cars (except premium)

Renault K-ZE concept car, source: auto.ndtv.com

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Fires in vehicles pose a significant threat to life and property

- About 1% of busses catch fire every year (according to statistics for Germany and USA).
- In the USA, vehicle fires account for 14% of reported fires and 16% of fire fatalities.
- No evidence of increased frequency of fire event in current EV fleet by comparison to ICE car fleet
- EV fires can occur during charging, post crash (most frequent, 50%) or at rest / while driving
- Pictures: car dropped
  20 m vertically → hitting ground at 70 km/h

Figure 4 Test 1 – The photo is taken 2 min after the drop, and large amount of smoke are produced from the battery

Boe A.S. (2017) Full Scale EV Fire Test, Brandposten #55, p. 8 - 10

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The main Risk is a Battery Fire in an Electric Vehicle

- Battery contains a high amount of chemical energy densily stored in a confined space. The combustion energy is about 5 to 20 times the electrical energy stored in the battery.
- Also the electrical installations and peripherals need to be well protected against fire risks from higher voltages and currents than in combustion engine cars.
- Smoke release before the actual thermal runaway (often with some delay), with white smoke and
- potential emission of highly toxic hydrogen fluoride (HF) from the decomposition of the electrolyte (e.g. LiPF6), also dangerous for fore fighters
- Re-ignition of an extinguished car is frequently observed.

PHOTO: ANDREAS SÆTER BØE, SP FIRE RESEARCH AS

Figure 5 Test 1 – The photo is taken 8 minutes after the drop. At this point the car has started to burn vigorously.

Boe A.S. (2017) Full Scale EV Fire Test, Brandposten #55, p. 8 - 10

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Fire Safety Challenges of E-Vehicles – they burn differently!

A Smart in Reutlingen, Germany, 2017
Battery finally extinguished by dumping into water container!

Source: Adrian Röhrle, Brand eines Elektrofahrzeuges, Brandschutz 2018/06, p. 446

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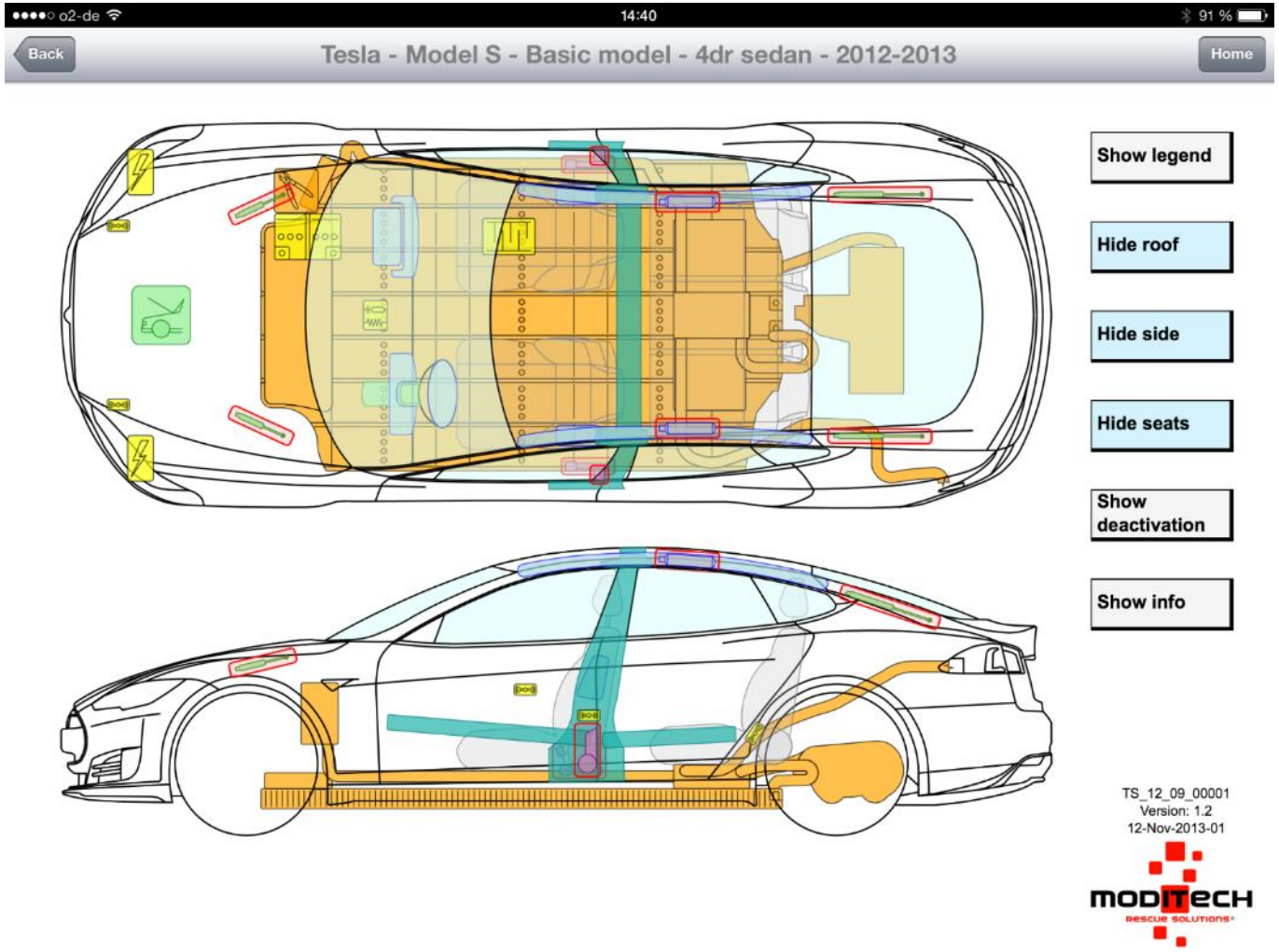
Challenge for Rescue Services and Fire Fighters: de-activation of electric system and critical locations



Source:
www.moditech.com

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Orange is the new Black: Engineering Plastics in EV Cars – with FR

For Full Hybrid (FHEV), Plug-in Hybrid (PHEV) and Battery EV → ca. 1.5 kg / car

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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

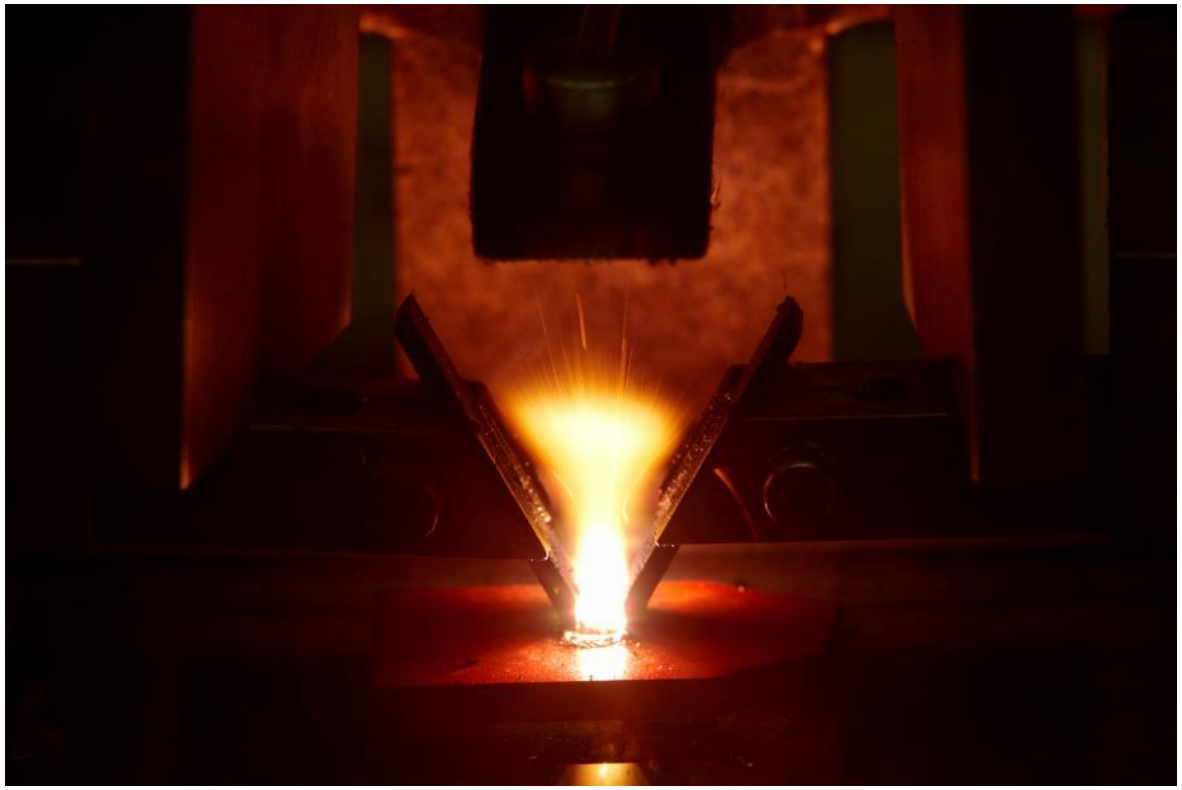
Miniaturization: enabled by maximum tracking index (CTI 600 V)

Complex shapes: high-flow capability allowing thinner walls, design flexibility and size eduction (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



CurrentTracking 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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UL 94 Vertical Test – will it become the dominant test?

photo: © R. Baumgarten, Clariant

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Charging Stations and Connectors

BMW i3, photos: © A. Beard

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Charging Stations and Connectors

DIN EN 61851 defines charging modes and variations:

- Alternating current up to 16, 32, 63 A (3 phase)
- Direct current up to 200 A and 1000 V

→ High currents for prolonged time → potential danger!

Source: VdS 3471 Ladestationen für Elektrofahrzeuge 2015-06 (01)

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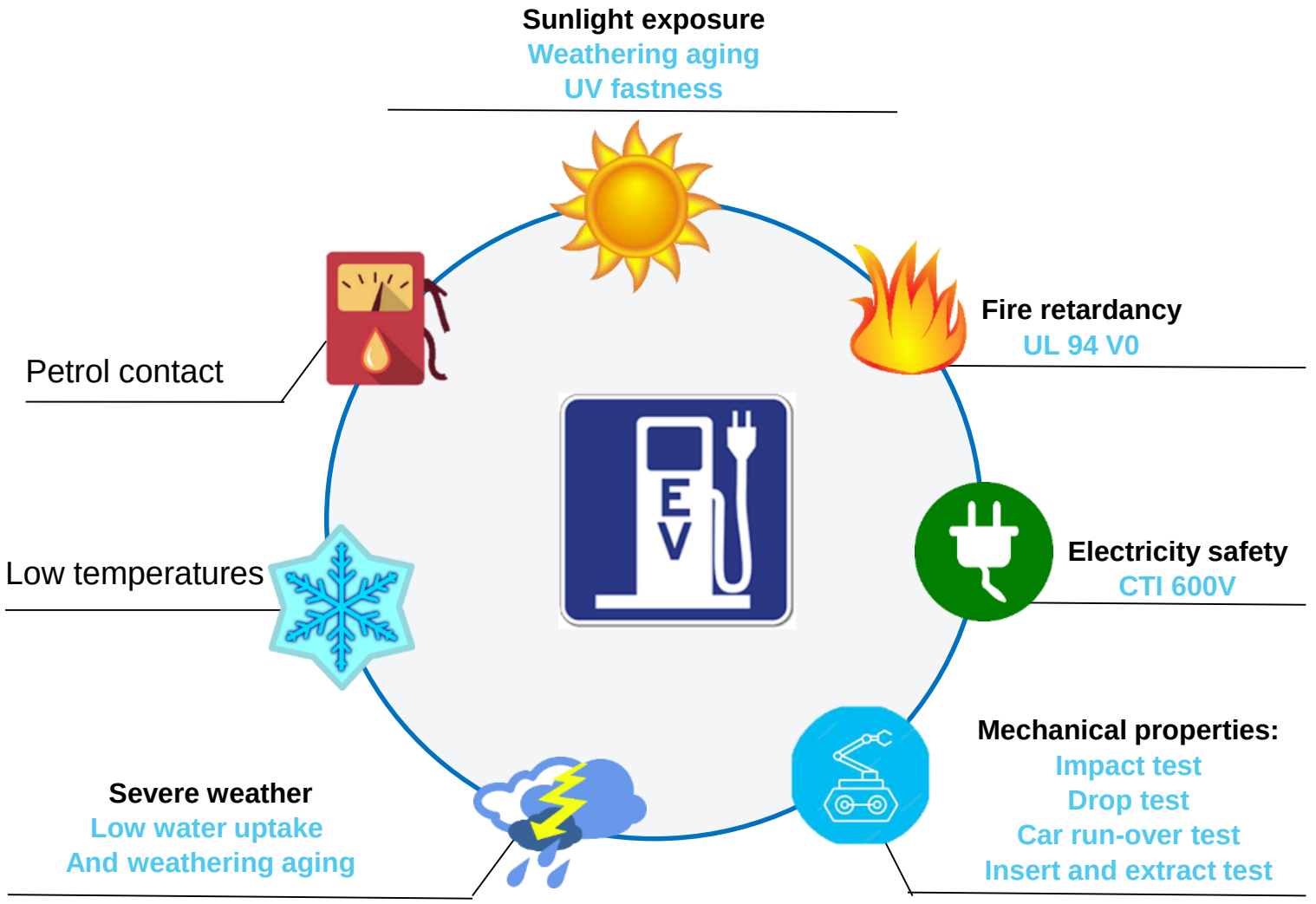
Use environment of charging piles



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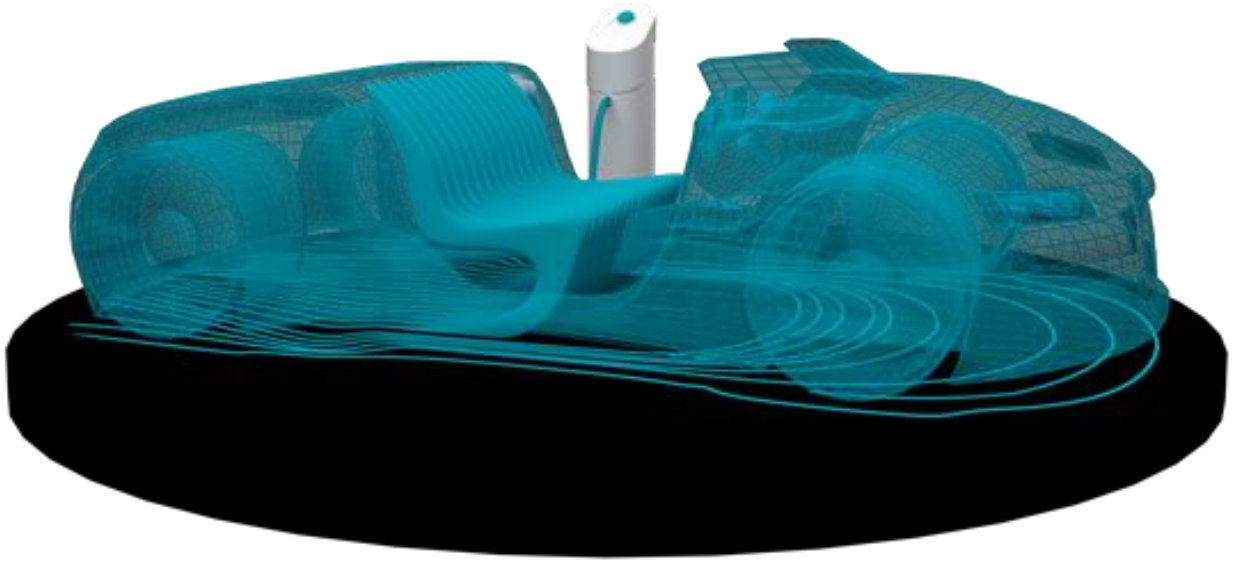
Clariant Flame Retardants for automotive plastics

Clariant has a broad portfolio of additive solutions that help to make plastics safer, look better, last longer and be more sustainable. Some of our innovations:

EXOLIT® OP 550 and 560
Preferable flame retardants for polyurethane foams

EXOLIT® OP 1400
For charging infrastructure and under the hood applications



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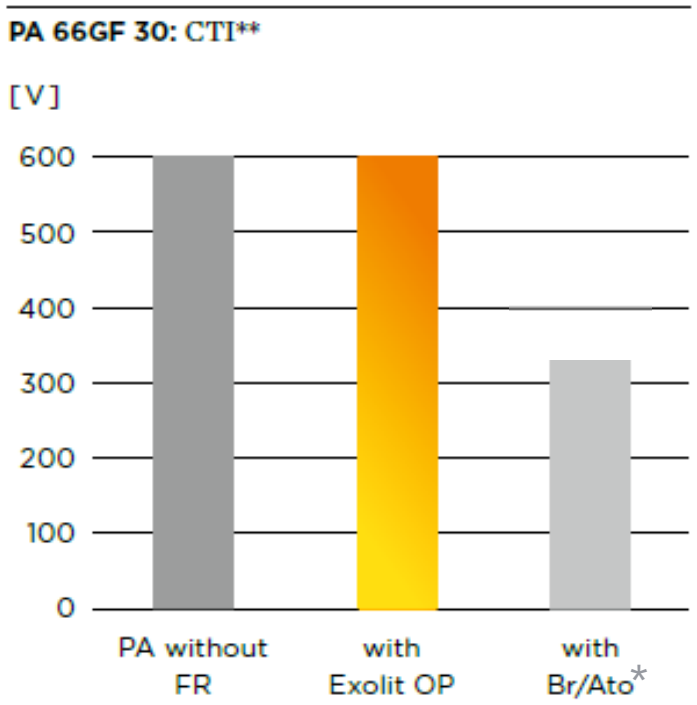
Compounds containing Exolit® OP 1400 achieve CTI up to 600 V, fulfilling high speed charging requirement



PA 66 GF30 with Exolit® OP achieves highest classification (PLC 0)

PLC = performance level category

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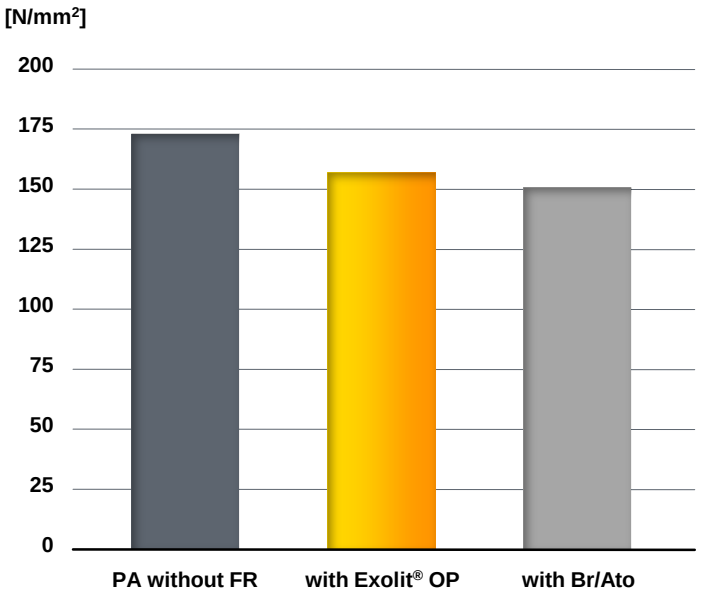
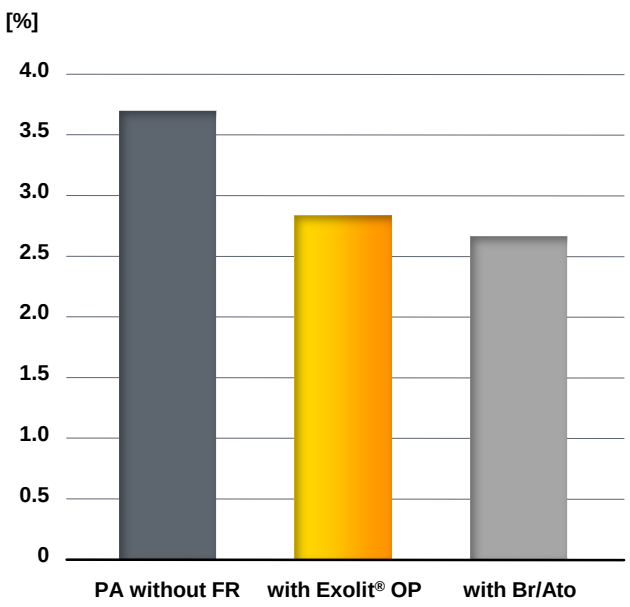
With Exolit® OP 1400, PA66 GF30 is more elastic and less brittle, and therefore able to pass impact and car run-over test

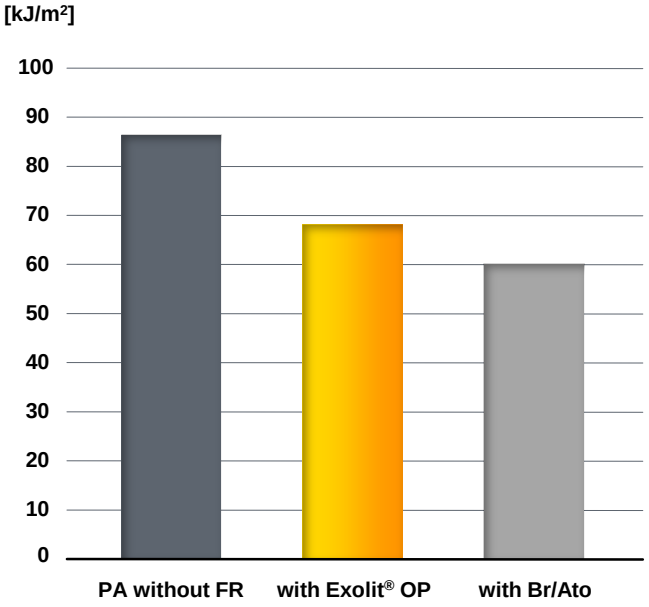
PA 66GF 30: Tensile strength at break**



PA 66GF 30: Elongation at break**



PA 66GF 30: Impact strength**



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Exolit® OP 1400 achieves the Clariant 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

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 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 560: A preferable flame retardant for polyurethane foams

Non-halogenated Exolit® OP 560 is an excellent choice for upholstering anything from car seats to padded doors, headliners and panels. It has been confirmed as a preferable flame retardant for polyurethane foams by the US Environmental Protection Agency (EPA).

Benefits

- Low fogging and VOC values
- High efficiency
- High polymer compatibility
- Reduced risk to health and environment

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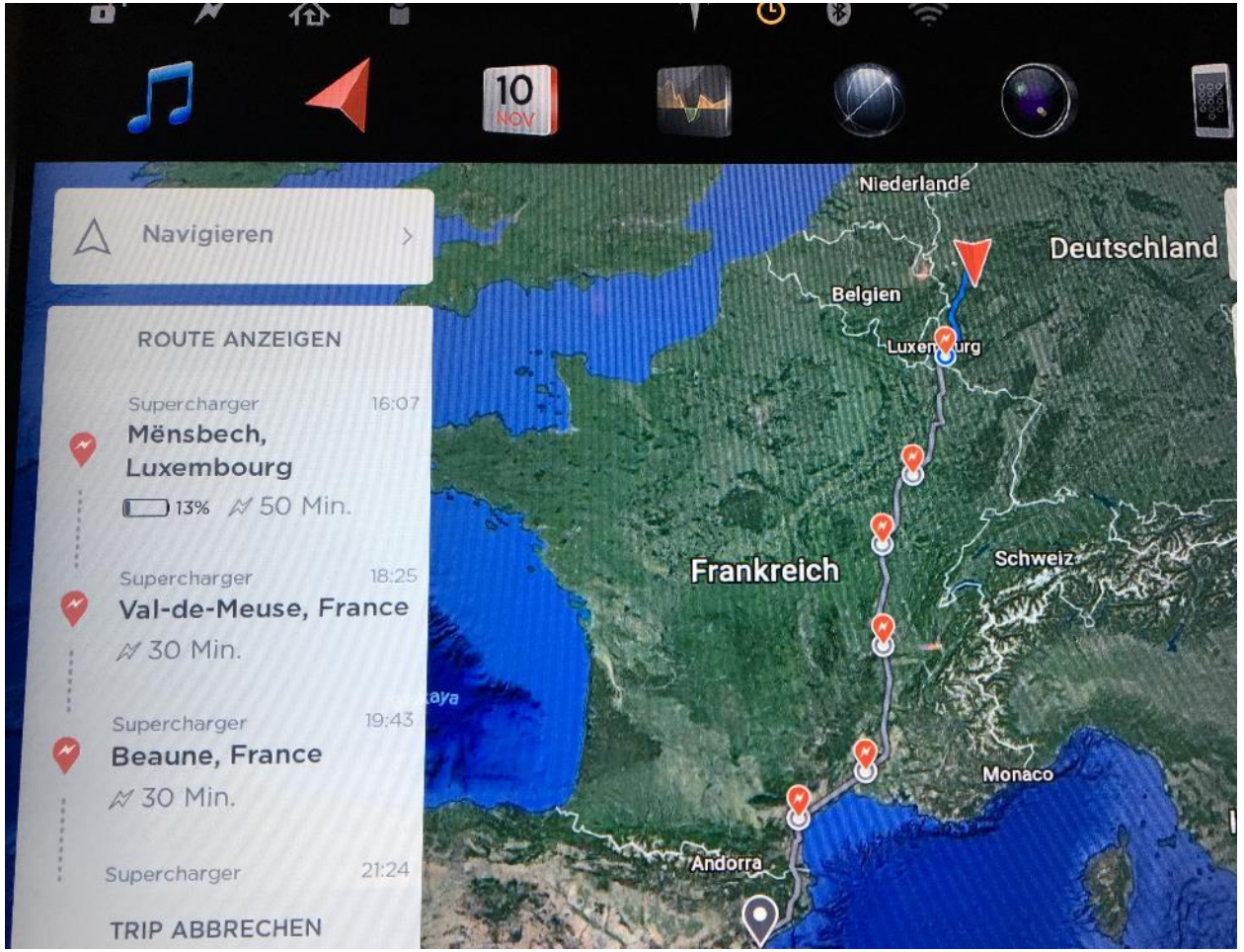
Summary and Conclusion

- Electric Vehicles are growing quickly in numbers, China and the USA are front-runners
- Electric Vehicles have different fire risks because of high voltages and currents during charging and the battery with a large amount of electro-chemical energy
- The battery as well as peripherals need to be protected against fire risk by using appropriate, flammability rated materials
- Clariant's Exolit® flame retardants provide a sustainable solution to some of these challenges
- Orange is the new black ☺



Tesla Model S Screenshot (A. Beard)

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