New Performance and Safety Challenges for Plastics

ELECTRO MOBILITY
Why Electric Vehicles?

Reduction of reliance on fossil fuel → limited resources

Reduction of carbon dioxide emissions → less greenhouse gas emissions

Simpler technology: 200 parts in electric drive vs. 1200 parts in conventional combustion engine drive
E-Vehicles – “simpler” technology also gives you more space ...
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]

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

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

Source: International Energy Agency 6/18
E-vehicles in China
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
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
The main Risk is a Battery Fire in an Electric Vehicle

- Battery contains a high amount of chemical energy densely 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.
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
Challenge for Rescue Services and Fire Fighters: de-activation of electric system and critical locations

Source: www.moditech.com
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
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

UL 94 Vertical Test – will it become the dominant test?
Charging Stations and Connectors
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)
Use environment of charging piles

- Sunlight exposure
  - Weathering aging
  - UV fastness

- Fire retardancy
  - UL 94 V0

- Petrol contact

- Low temperatures

- Severe weather
  - Low water uptake
  - And weathering aging

- Mechanical properties:
  - Impact test
  - Drop test
  - Car run-over test
  - Insert and extract test

- Electricity safety
  - CTI 600V
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
Compounds containing Exolit® OP 1400 achieve CTI up to 600 V, fulfilling high speed charging requirement.
With Exolit® OP 1400, PA66 GF30 is more elastic and less brittle, and therefore able to pass impact and car run-over test.
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

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) [more]
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
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 😊.
Drive safely!

THANK YOU FOR YOUR ATTENTION