Lightweight design for future mobility concepts

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Urbanisation

People move to cities for work, hoping to increase their standard of living. As a result, cities grow and become more crowded, congested and polluted.

Emerging economies

As globalisation increases and societies progress, new centres of growth emerge around the world with their own approach to the future

Four Factors are driving changes in **Environmental** New the Automotive generations changes landscape Human activity impacts environment, Overall world population grows while resources become more scarce, consumer preferences shift with emissions cause changes in the technology savvy millennials and atmosphere and nature people generally living longer. Lightweight design for future mobility concepts | SPE Houston Feb 2019 by M. van Tol 21

Regulators prompt fuel efficiency, emission reduction, and recycling policies Industry hunt for weight reduction, alternative powertrain technology and improved raw material use



Vehicle lightweighting via new material and technology use, resizing of parts and functional integration

Environmental changes

Human activity impacts environment, resources become more scarce, emissions cause changes in the atmosphere and nature Combustion engine optimisation plus new developments in range extended, battery electric and fuel-cell powered vehicles

> Production waste reduction, increased use of recycled materials and improved end-of-life recyclability

Advanced material concepts help to address new drivers and trends for the Automotive market



The scientific basics of mobility Weight influences the energy consumption of a vehicle



Total resistance:
$$F_{total} = F_{AD} + F_{RR} + F_{Acc} + F_{RG}$$

Vehicle mass is critical for the force needed to move forward

Source: Flaticon, Advances in Automobile Engineering 2016;5;2, Chandran and Joshi; "Electric vehicles and driving range extension-A literature review

- Base electric load (heater, air condition, music system..)
- Power to overcome aerodynamic drag or air resistance
- Power to overcome rolling resistance of the wheels
- Power to work against gravity when driving uphill
- Power for overcoming inertia in acceleration





...and electrical vehicles are gaining weight!



Weight comparison of ICE, PHEV and EV – Example: VW Golf [kg]

Source: Roland Berger, Automotive metal components for car bodies and chassis - Global market study



Why are plastics the right choice to address lightweight automotive challenges?





Borouge

Solutions that allow for design freedom and flexibility for vehicles with hybrid or electric powertrains... and new concepts enabled by autonomous driving

- Superior lightweighting with novel fillers and foaming capabilities
- Metal replacement in areas of lower operating temperature
- Mono-material concepts such as tailgate, integrated PV sun-roof and instrument panels

"We are committed to developing value-creating polyolefin solutions that enable our customers to think about the material science of cars in a different way." Nio ES8, a leading Chinese battery electric SUV with a centre console carrier made from

Fibremod[™] CB201SY

Key material requirements

- Easy processability
- Excellent mechanical performance
- Low density with effective weight saving

Customer value

- Part weight reduced by more than 20% when compared to conventional materials solutions (Polypropylene with 40% glass fibres)
- Suitable for injection molding
 Good dimensional stability





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"We are committed to developing value-creating polyolefin solutions that enable our customers to think about the material science of cars in a different way." Pioneering on PO solutions for **<u>structural foam</u>** injection moulding applications



2005 BMW 7 Series
2007 BMW 5 Series
2008 BMW X5, X6
2010 BMW 3
2012 BMW Mini
2013 VW Golf 7
2014 VW Golf 7- Sportsvan
2015 BMW 2 series
2016 BMW X1

More than 12 years track record in the area of foamed instrument panel carriers!

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"We are committed to developing value-creating polyolefin solutions that enable our customers to think about the material science of cars in a different way." Pioneering on PO solutions for <u>visible class-A</u> <u>surface</u> foam injection moulding applications

- New developmental grades
- Designed for easy foamability
- 5 15% weight reduction potential compared to compact reference
- Gaining additional degrees of freedom in the part design (wall-thickness reduction)





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Providing PO solutions for <u>lightweight</u> <u>frontend module applications</u>

- Highest mechanical strength for maximum freedom in design
- Product performance allows for good processability and surface quality despite high reinforcing fibre content
- Borealis Moldflow and Engineering support





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Providing PO solutions for <u>lightweight tailgate</u> <u>applications</u>

- Mould in colour-structural visible parts
- Complexity reduction (2 instead of 3 parts)
- Full PP tailgate for easy recyclability (when combined with a PP skin material)
- Weight reduction potential
- Mould in colour-structural visible parts





Borealis' Polyolefins are well positioned as key materials for tomorrows mobility concepts

New e-Vehicle concepts enabled with Polyolefins

- Re-thinking material science behind new designs enabled by e-powertrains an the continuous need to reduce weight
- Applying our PO technology to change part/module design
- Developing mono-material solutions enabling recyclability including tailgate, integrated PV sunroof, and full PP dashboard

Borealis delivering benefits in a changing automotive environment

- Daplen[™] and Fibremod[™] PP compounds are the right choice to address automotive lightweighting challenges for range extension
- Grades for a changing heat landscape in the vehicle
- Desire for novel interior and exterior features and effects
- Durability and aesthetics in the new world of mobility-as-a-service



New PP compounding plant in Taylorsville nearing completion with start-up early 2019

- Strategic location in the southeast United States automotive cluster, approximately
 60 miles north of Charlotte, North Carolina
- A brownfield investment in a brand new shell building with the possibility for future expansion
- Plant scheduled to become commercially operational in early 2019
- Production capacity to be approximately 66 million pounds (30 kt) utilizing a number of new polypropylene (PP) compounding lines
- Target product portfolio covers Daplen™ family of PP thermoplastic olefins (TPO) and Fibremod™ range of PP short glass fibre (SGF) reinforced materials









laylorsville.

Thank you

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