The Right Chemistry to meet the Future of e-Mobility

The automotive industry is facing unprecedented challenges in the foreseeable future. The COVID-19 pandemic has caused considerable setbacks in the industry. Automakers continue to feel the pressure of decreasing sales and supply disruptions. To complicate matters further, established automotive original equipment manufacturers (OEMs) are likely to face increasing disruptions in the coming years.

As the world battles air pollution and climate change, the emphasis on sustainability is ever growing, so too is the scrutiny over the role the automotive industry plays in carbon emissions. The industry has to also manage and respond to the growing changes in consumer perceptions and expectations. Much of the disruptions the industry will be facing will be the emergence of megatrends – **A**utonomous driving, **C**onnectivity, powertrain **E**lectrification and **S**hared mobility (ACES). The need for a comprehensive transformation of the automotive industry will affect the entire value chain, including companies that supply chemicals for numerous automotive applications.

As consumers worldwide are exploring ACES capabilities in their future mobility options, they also consider higher safety standards as a key reason to purchase a new vehicle above other factors like cost of ownership, vehicle design and performance. Sales of EVs are expected to hit over 30 million units by 2030 as the world is fast transitioning to mobility solutions that are cleaner and greener for the earth.

The transition to the world of eMobility and electric vehicles (EVs) manufacturing will not be easy as they the industry will have to deal with falling margins while investing heavily in eMobility and new, consumer-orientated innovations to stay relevant and successful in the coming years. On a positive note, it presents opportunities for the automotive industry to innovate and adopt advanced technology solutions going forward.

OEMs are already focusing on eMobility technologies that will make vehicles more cost efficient, with extended driving range and longer lifecycles. This scenario presents opportunities for the automotive industry to shape the future of the mobility landscape and is driving innovation developments in the automotive industry.

EVs do not differ all that much from their internal combustion engines (ICE) counterparts apart from their motor. The electric motor produce much less heat than ICEs and this allows for different combinations of chemicals and materials to be used. With more emphasis on EVs, the demand for ICE materials like advanced engineering polymers, and engine-related chemicals such as emission catalysts, fuel additives, and lubricants will face a diminishing market. Instead demand will be high for battery-related chemicals for the anode, cathode, electorate, and separator. Likewise demand for light-weight plastic compounds and flame retardant, electrical insulation and thermal management systems will also increase.

As the automotive industry transforms and evolves to serve the changing needs of customers, opportunities will be available for chemical companies for collaborations such as joint ventures and alliances. They can go into co-creation partnerships with OEMs to develop a differentiated plastics and materials portfolio in advanced composites, polymers and lightweight steel alloys. Their role in the new e-Mobility value chain would be more critical in areas such as technical vehicle innovations around battery performance as the ICE market begins to decline.

The key to sustainable mobility is eMobility combined with renewable energy. The success of eMobility will be not only how quickly the performance, driving range, weight, safety and reliability of EVs can be improved, but also how manufacturing costs and economic efficiency of the battery systems can also be enhanced. With EV sales expected to increase, the impact on global demand for batteries is expected to be massive. Efforts are ongoing to rethink the next generation of battery designs and chemistry. A rapidly growing battery materials market presents challenges in creating materials with

superior performance, which are also affordable and sustainable.

BASF understands the evolving nature and expectations the industry is facing. As the world's number one chemical supplier for the automotive industry, and with an extensive portfolio of eMobility solutions backed by decades of engineering expertise, BASF is committed to being the ideal partner to create current and future eMobility applications of the highest standards for safety, durability and mechanical execution.

In light of the challenges and disruptions the industry is facing, BASF has identified key areas that will ensure their future success in the eMobility era.

Expanding global CAM footprint

By 2030, about 30 per cent of all cars produced will be fully electric or plug-in hybrids. And about 70 per cent of EVs will be produced in Europe or in China. This also brings enormous potential in the CAM market, by a projected 20 per cent or more annually through 2030. To tap on this, BASF is scaling up production capacity for precursor cathode active material (PCAM) and CAM in these two regions and North America, which will produce an unrivalled annual CAM capacity of 160 kilotons by this year (2022).

Advancing CAM technology

As one of the largest chemical suppliers to the automotive industry, BASF has extensive knowledge of the automotive market and battery materials chemistry, and unparalled access to OEM customers. This insight allows BASF to drive innovation and develop future cathode materials by investing in research and development. With R&D labs and applications development centers intentionally located near customers all around the world, BASF is able to pursue in-depth collaboration for product development and qualifications. BASF also taps on some of the brightest minds in the world through academia collaboration on next-generation battery materials development.

Any material used in eMobility applications has to meet high performance

standards during normal driving and daily operation. Material performance is therefore the key to successfully implementing numerous eMobility solutions. BASF's range of highly versatile and high performing engineering plastics, polyurethane systems and specialty elastomers coupled with a dedicated team of experts in engineering, design and materials can help OEMs meet their ambition for high performance eMobility components and applications.

New quality and safety requirements in the automotive industry brought about by electrification has in turn fuelled demand for high standards on plastic materials. These electric properties are relevant where there is risk of contamination between live electric wires in connectors and plugs, or a risk of an electrical breakdown in the busbars, or threats due to powerful electromagnetic fields in power electronics housing. There is also the safety requirement to address fire ignition issues where there are sensitive materials in battery components and modules.

Charging Infrastructure

Another big challenge in electrification is the charging infrastructure for the vehicles. The charging station is an indispensable partner to the electric vehicle. How it works is as important as how safe and efficient it is in daily use and its long-term reliability. The key components in the charging infrastructure consists of the charging station, the loading gun as well as the power inlet, which is inside of the vehicle. These components have to exhibit excellent mechanical performance with outstanding reliability and safety for these applications.

BASF's sophisticated polyamides (Ultramid®) and polybutylene terephthalates (Ultradur®) offer solutions for the charging infrastructure's numerous components like the breakers, switches and terminal blocks found in the main charging unit. Ultramid® solutions are UL94 V- compliant and offer good processability and flame retardant properties which are vital in applications like the charging inlet and the housing on the loading gun and contact carrier. Elastollan® with its high resistance to chemicals and UV, and excellent wear

and tear resistance, adds that additional haptic element on the gun's exterior surface. Housing for the charging station's power electronics like the AC/DC converter uses Ultradur®, which has low water absorption properties that renders it largely independent of the climatic surroundings, vital for safety-relevant components that have to be reliable and long-lasting.

Electromagnetic Interference (EMI) Shielding

The increased use of sensitive electronics and equipment in eMobility vehicles makes them highly susceptible to EMI. The radiated and conductive emissions from this interference can disrupt circuits and cause safety and performance issues.

Where metals, with its intrinsic shielding properties, were the norm, BASF offers polymer solutions such as Ultramid®, Ultramid® Advanced and Ultradur® engineered plastics that can be combined with a metallic coating with EMI-shielding properties that are equal to full aluminium housings. These are not only cost-effective with lightweight potential but also provide a higher freedom of design with manifold function integration possibilities.

Power Management Applications

High voltage housing for power electronics, safety devices and bus bar connector need flame retardancy, electric isolation, heat aging and orange colourability with easy processability, key criteria for any material consideration. Busbars are ideal for distribution of high-voltage power from the battery packs to the EV's motor, axle and its other devices. With proper materials, busbars can assist thermal management along with distributing power. BASF's Ultradur® and Elastollan® flame retardant solutions offer very high electrical isolation capabilities for HV busbars with excellent resistance against thermo-mechanical stress. These also provide customers with improved processability and a high freedom of design with potential for function integration.

High Voltage Connectors

Distributing high voltage power in eMobilty has safety risks like electric shocks, fire and high temperature issues. The High Voltage (HV) connectors play a crucial role in safe and reliable HV power transfer.

BASF's wide range of matrix polymers, such as Ultramid®, One J, Ultramid® Advanced and Ultradur® are non-halogenated flame retardant, which are safer for both individuals as well as the environment. They have high electrical insulation and outstanding long-term heat aging and hydrolysis resistance.

These polymers also reduce the corrosion and wear in the customers' processing unit as well as the mould. A big production advantage for the customer is having the polymers precoloured in orange with excellent colour stability.

NVH reduction solutions

Reducing noise, vibration and harshness (NVH) is one of the major challenges to keeping the EV's reputation for being quiet and offering a smoother ride.

In the move away from loud traditional internal combustion engine (ICE) and the quest for more efficient vehicles, engineers have to redefine and refine the level of sound, comfort and also feel of EVs.

BASF's range of NVH solutions like Elastollan® combine acoustic isolation at high frequencies with high dampening at large amplitudes. These properties help OEMs design optimal innovations in acoustic comfort, vehicle dynamics and safety.

In new EV architecture, the trend is towards a shortened frontend, which could compromise the safety of the car's occupants in the event of a crash. BASF has, in a co-creation effort with a global OEM, come up with new material classes like high-energy-absorbing plastic frontend, 3D formed crash absorbers from polyamide particle foam with high energy absorption, and stiff

energy absorbing pultruded polyurethane and thermoplastic profiles to provide next-level crash safety protection.

Going forward

As OEMs and suppliers are developing strategies to stay ahead and solve the challenges associated with electrification, they can leverage on BASF's extensive expertise in battery chemistry and materials to help them drive forward in this new normal in the automotive industry.

eMobility innovations require high-performance material solutions, and BASF understands the key to the successful implementation of eMobility applications lies in material performance. BASF ensures customers will gain the advantage of a unique co-creation partnership when they rely on BASF's broad portfolio of high performance material solutions.

From expert design and engineering support, to material selection, to simulation and testing, to serial development, customers will be able to create new trends backed by BASF's deep insight within the automotive value chain.

Reference links

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