PLASTIC OMNIUM

PRESS KIT

PLASTIC OMNIUM, AT THE FOREFRONT OF TRANSFORMATIONS IN MOBILITY AT CES VEGAS 2023

January 2023

Plastic Omnium at CES 2023: at the forefront of tomorrow's mobility

Plastic Omnium is proud to live up to its purpose, "Driving a new generation of mobility", at CES Las Vegas 2023, cementing its place at the forefront of new solutions for a more sustainable, more connected and safer mobility.

The leading player in a fast-changing market, Plastic Omnium leverages its industrial successes to drive its standards ever higher. And because innovation is at the heart of its DNA, Plastic Omnium is ramping up efforts to consolidate its competitive advantage, turning extensively to digital technologies to provide solutions for new forms of mobility.

Numbering five separate divisions, with the historical body panel, fuel tank and module divisions joined by two new hydrogen and lighting divisions, Plastic Omnium is accelerating its transformation as a Group that is more innovative and more technologically focused. In 2030, Plastic Omnium will generate 40% of its revenue from technologies that do not feature in its current product line-up. It forecasts revenue of 15 billion euros in 2030.

The innovations presented here underline the step-change sweeping a Group that has embarked on a far-reaching transformation of its product line-up, delivering greater added-value to its customers.

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Plastic Omnium presents its innovations at CES Las Vegas

Vehicle body panels are no longer a commodity, they are parts that are packed with technology incorporating complex functions such as advanced lighting solutions and a range of ever more advanced sensors.

The aim? More safety.

4D imaging radar that can interpret surroundings in 3D and real-time, no matter the weather conditions (page 6).

Smart lighting solutions capable of anticipating and informing (page 24).

Convenience, comfort, looks: mobility is evolving to reflect changing consumer tastes.

The aim? More enjoyment.

A **Trends Wall** featuring all the design possibilities for vehicle body panels (page 11).

Interior lighting solutions and lighting projections for greater user comfort (page 25).

A **front trunk** for electric vehicles that offers new possibilities for consumers (page 27).

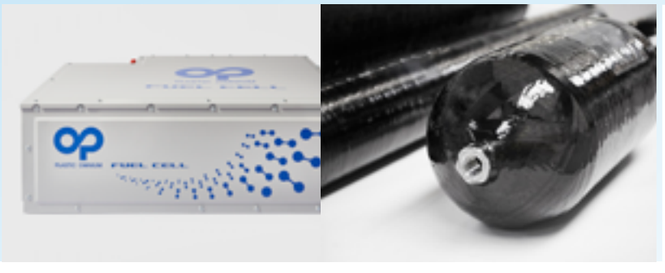
A **LID charging module**, for a safer and more comfortable charging for users (page 29).

We are convinced that the energy transition will not use a single type of powertrain but a combination of solutions, and we are ready!

The aim? Reduce CO_2 emissions.

A **Trends Wall** displaying materials of the future for vehicle body panels (page 11).

Innovations in **hydrogen** (page 18).



Innovations in **batteries and power electronics** (page 19).

1 A safer mobility

2 A more appealing mobility

3 A more sustainable mobility

MOBILITY designed around SOFTWARE

I. Plastic Omnium transforms body panels: from a passive part it becomes a sensitive skin

Plastic Omnium and Greenerwave transform bodypanels components into a giant radar system using 4D imaging radar

Greenerwave has developed revolutionary wave control technology that paves the way to designing a new generation of automotive radar. Plastic Omnium has mastered the large-scale production of this technology, as well as its integration into plastic body parts. **Welcome to the era of smart plastic!**

4D imaging radar incorporates 3D and speed.

This is a real revolution. Bumpers play a very big role in a vehicle's aesthetics as well as their primary function of providing protection. Today, Plastic Omnium and Greenerwave are making use of the large surfaces that bumpers offer to transform them into giant radars offering unmatched real-time 3D imaging capabilities.

More than simply a new radar, this innovation means that all body parts are able to house smart surfaces that offer imaging capacities close to lidar, but affordably and without the drawbacks.

Looking to the future and the arrival of the software-defined vehicle, Plastic Omnium is developing a product that fits the bill to perfection.

4D imaging radar is a disruptive technology created by a collaboration between Plastic Omnium and Greenerwave.

HOW IT WORKS

One of the Group's traditional areas of expertise, Plastic Omnium develops painted plastic bumpers and builds into them components such as radars. Thanks to its engineering know-how and extensive experience of industrial processes, particularly via optimization of the various layers of materials and paint, Plastic Omnium's bumpers can be made transparent to the electromagnetic waves sent and received by the radar.

The Group's current strategy is to design and manufacture radars as a way to increase its added-value by vehicle. The aim? To sell radar components or radar-equipped bumpers directly to a automakers.

Radar was invented in the early 20th century for detecting ships in foggy weather. This is why it is so robust: it was originally conceived to see through difficult conditions.

Greenerwave and Plastic Omnium are fully complementary in the way they work together to develop 4D imaging radar: one partner is expert in electromagnetic waves, the other in industrial processes and vehicle body parts.

Greenerwave is a French deep-tech startup stemming from Institut Langevin (CNRS/ESPCI) in Paris. It has developed an innovative electromagnetic wave control technology based on configurable smart reflectors. The technology uses simple, low-cost electronic components that are paired with a series of innovations in control and imaging algorithms.

Plastic Omnium is world leader in the design and manufacture of body panels it renders transparent to radar waves. Plastic Omnium also has significant expertise in the development and production at scale of electronic systems for the automotive industry. It is now leveraging this expertise with its line of 4D radar imaging products.

The exclusive partnership between Plastic Omnium and Greenerwave brings together a startup developing a cutting-edge technology with an industrial company and specialist integrator from the automotive world, offering the market a revolutionary 4D imaging radar product for driving assistance functions.

Plastic Omnium knows how to render a plastic body "transparent" for electromagnetic waves.

Understanding how 4D imaging radar works

The 4D imaging radar is made using a standard radar chipset connected to several antennas located on the vehicle's bodywork. This standard radar creates a wave that is guided to the antennas. The antennas, transmitters and receivers, act as smart electromagnetic reflectors that can reflect the waves in the direction required.

Waves reflected by these smart reflectors spread in front of the vehicle and are reflected as echoes by objects in the surrounding area. Receiving antennas pick up the echoes: specialist algorithms can then reproduce the vehicle's surroundings and categorize the objects found there.

What is unique?

With a conventional radar, the antennas (a few centimeters in size) are located very close to the radar chipset: this results in a narrow aperture and, ultimately, low resolution. The uniqueness of the concept from Plastic Omnium and Greenerwave lies in the fact that the large antennas fitted to bumpers are physically separated from the chipset. Not only does this technology increase the aperture, and therefore the resolution of the radar, it also maximizes the area receiving radar echoes: they are received across the entire surface of the bumper rather than just the small surface used by conventional radar, meaning that far more information about the vehicle's surroundings is gathered.

4D imaging radar fills in the blanks left by conventional sensors

There are currently four main types of sensors used for driver assistance.

1 **RADAR**
Extremely robust, radar is relatively unaffected by outside weather (rain, snow, fog, etc.) and light conditions. It can detect objects in the vehicle's surroundings and measure their speed. However, its low resolution means the surroundings it sees are highly pixelated, making it of little use for imaging, which involves categorizing the nature of objects observed (cars, pedestrians, cycles, motorcycles, animals, etc.).

2 **CAMERAS**
Cameras are very precise and offer the best resolution of all driver assistance sensors, but are highly sensitive to outside conditions (rain, fog, light level, etc.). They do also offer unique features such as recognizing colors and signs, which are mandatory for certain driver assistance functions (for instance, recognizing traffic signs).

3 **LIDAR**
Offering good resolution, lidar can create relatively accurate images of the vehicle's surroundings but remains fairly sensitive to weather conditions. It is expensive and complex to integrate into body panels.

4 **ULTRASOUND SENSORS**
These sensors are used to detect obstacles in a vehicle's immediate surroundings and are used primarily for park-assist functions.

4D imaging radar: a unique technology for the market

- **It offers good resolution**: resolution similar to lidar (0.1° azimuth).
- **It can categorize objects to create images of complex surroundings**, unlike conventional radar which can essentially only detect objects.
- **It is multi-mode**, able to see near and far simultaneously.
- **It is upgradeable**: 4D radar can use the same electronic platform to adapt to a customer's needs across an entire range of vehicles, using the same interface, simply by changing the size and/or number of antennas.
- **It integrates easily into vehicle electronic systems**: the six-antenna 4D radar replaces three radars fitted to a front bumper (one front-end and two for the corners), and simplifies automakers' electronic architecture.
- **It is easy to mechanically integrate into a vehicle**: the fact that the antennas and radar chipset are separate offers a great deal of flexibility in terms of how the system is mechanically integrated into the vehicle, avoiding the styling compromises that using radar can lead to.
- **It reduces repair costs**: separating the radar chipset from the antennas means that in the event of an impact only the damaged antenna needs replacing.
- **It is robust:** If any single antenna is disconnected or broken, the 4D radar can work in degraded mode using the other antennas, meaning that imaging of the surroundings continues to function.
- **It is available**: its imaging capabilities are unaffected by outside conditions (weather, light, etc.), unlike lidar or cameras.
- **It uses little power**: less than 15W for the six-antenna version.

We supply automakers with radar systems that offer excellent resolution (below 0.5°) with a wide field of view (above 180°) and considerably simplify electronic architectures while remaining robust and reliable no matter what the outside conditions are (weather, light, broken antenna from an impact, damage to the bumper, etc.).

Driver assistance functions involve four stages:

1. **Perceiving what is happening in the surroundings**: there is something or there is nothing.
2. **Analyzing what is perceived**: is it a person, a car, a ball, or something else?
3. **Making a decision based on the analysis**: brake, accelerate, turn, etc.
4. **Taking action**: using the brake pedal, steering wheel, etc.

Plastic Omnium's work focuses on the first two levels, perception and analysis.

4D imaging radar: a response to increasingly strict safety regulations

Safer. The regulations Global Safety Regulation (GSR) in Europe, National Highway Traffic Safety Administration (NHSTA) in the USA as well as third-party bodies such as EuroNCAP and ChinaNCAP, require the implementation of ever more advanced driver assistance systems (ADAS) in order to improve safety for all road users. These ADAS functions need environment-perception sensors that are more accurate and robust: 4D imaging radar is a response to this requirement.

Plastic Omnium projects that it will begin production of the first 4D imaging radar systems in 2026 and is focusing primarily on premium automakers, robotaxis and self-driving heavy trucks.

This technology has excellent growth prospects: by 2025, it is forecasted to sell 15 million vehicles with Level 2 and a higher driving automation, rising to 22 million by 2032.

Plastic Omnium reveals its Trends Wall and explores the designs of tomorrow

Body panels, vital to the look of any vehicle

A bumper is what gives a car its final visual appeal. It is a strategic part that expresses a vehicle's personality. Plastic Omnium's core business involves translating the automaker's creative brief into a bodywork part that meets extremely strict specifications and the regulations that apply to the automotive industry.

Operational excellence covering every stage, from initial sketches to final delivery, innovation, quality, the reliability of the products it provides to its customers: these are the hallmarks of everything Plastic Omnium does.

For over 75 years, Plastic Omnium has been a key player in vehicle signatures, going beyond technical skills and regulatory compliance to offer new user experiences through its bodywork parts. Closely in touch with the latest trends, Plastic Omnium anticipates user demands so that is can offer automakers responses to newly emerging trends.

Plastic Omnium reveals its Trends Wall, a showcase presenting all the design possibilities, from the most traditional to the most disruptive, it offers its customers. Plastic Omnium understands the true extent of what is possible, unveiling its vision of tomorrow's body panel through the prism of three key trends:

- **All green**: where sustainability, style and performance meet
- ***"À la carte"***: current trends for no-limits customization
- **All in one**: design teamed up with technologies

Plastic Omnium combines the design-led approach vital to its customers with its expertise in integrated functions. The aim is clear: to make it possible for you to customize your vehicle, with approved solutions according to the design you choose, while also limiting your impact on the environment.

Plastic Omnium introduces new design solutions that meet the customer desire for vehicle customization.

Plastic Omnium's Trends Wall is a display aid used to choose combinations of shapes, materials and functions to pave the way for the vehicles of the future.

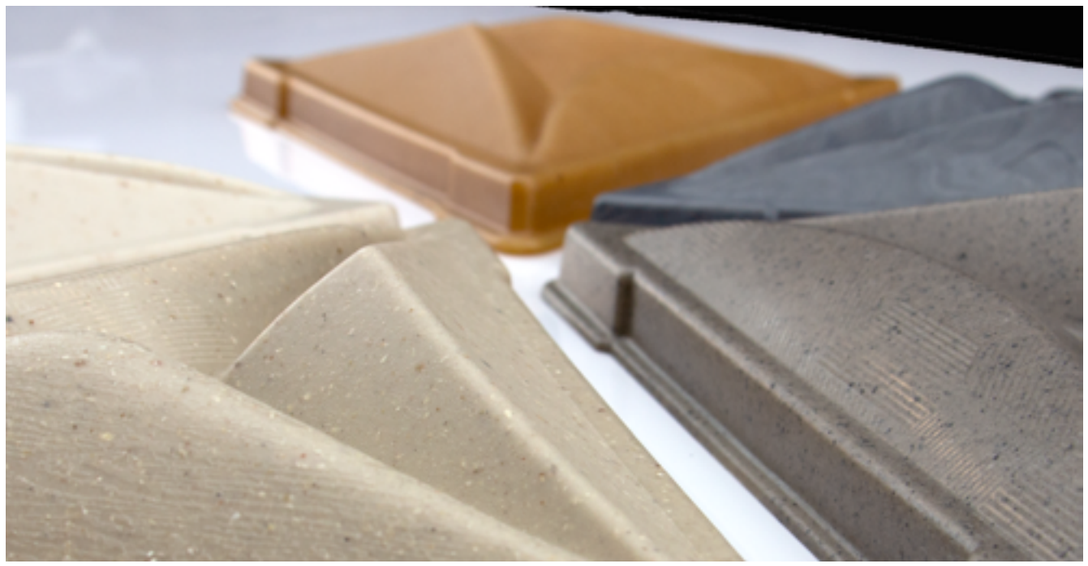
Plastic Omnium ramps up the sustainability of its products

Plastic Omnium is responding to automakers' growing insistence on environmental responsibility via the use of recycled materials, directly visible on bodywork parts or seamlessly integrated invisibly.

Plastic Omnium uses recycled materials in its body panels and is able to take this process to new aesthetic heights by using bio-sourced or recycled materials such as grape seeds and oyster shells. The aim? To diversify the range of looks and finishes without compromising the performance, quality and visual appeal of its body panels.

Plastic Omnium started investigating recycled materials over 20 years ago, which means it is now one step ahead of the pack when it comes to incorporating them into its products. Plastic Omnium has solved all technical issues and can use recycled materials while also meeting the very highest performance standards.

Today, Plastic Omnium can manufacture a bumper made from up to 50% recycled materials without any compromise in terms of look or finish.



II. Plastic Omnium sets out to conquer the US hydrogen mobility market

The leader in onboard hydrogen mobility systems, Plastic Omnium is presenting its latest innovations in the US: its high-pressure vessels and fuel cell system. Plastic Omnium offers all the technologies needed for hydrogen-powered vehicles, and has chosen to prioritize applications for commercial and heavy vehicles. It has already invested in its first high-pressure hydrogen vessels production line, on behalf of Ford in Michigan!

Ford selects Plastic Omnium to equip its demonstrator fleet of hydrogen trucks.

After significant commercial success in Europe and Asia, Plastic Omnium has won its first hydrogen contract in the US: Ford has tasked Plastic Omnium with developing and producing the 700-bar high-pressure type IV hydrogen vessels that will be fitted to its commercial vehicle prototypes. The aim? To have the first vessels ready for delivery by the end of 2023.

Plastic Omnium develops and manufactures high-pressure hydrogen vessels in the US at its plant in Adrian, Michigan, on a new line dedicated to hydrogen, produced in a factory of conventional fuel tanks - Plastic Omnium's historical know-how.

Plastic Omnium already has a major presence in the US with five plants producing conventional fuel tanks (three million fuel tanks produced in 2022). This is a formidable starting point for the development of Plastic Omnium's hydrogen energy technologies across the country.

The plant in Adrian, USA, produces one million conventional fuel tanks per year and is gearing up to produce hydrogen vessels on a large scale.

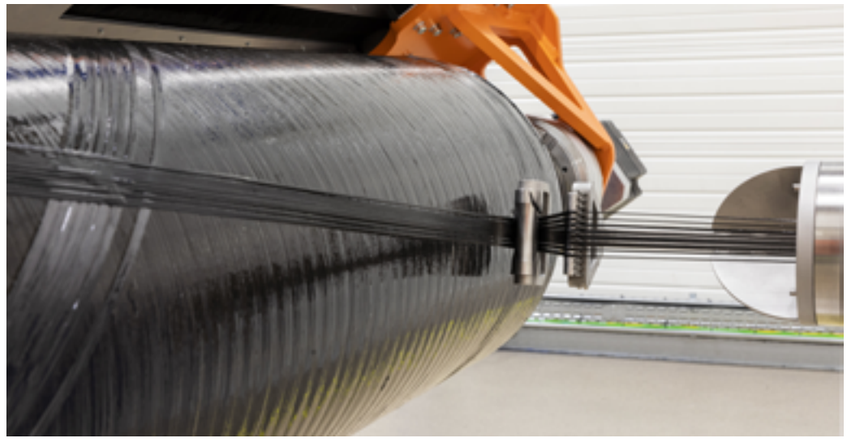
Plastic Omnium presents an extensive range of hydrogen vessels for use by all mobility segments, from small vehicles to heavy trucks

Hydrogen-powered cars are electric cars

Fuel cell electric vehicles have their own onboard electrical power plant to instantly produce electricity and power the electric motor. Battery electric vehicles store electricity on board, recharging their batteries from external charge points. Both types have an identical powertrain that uses electric motors to move the vehicle along the road.

Plastic Omnium heads the field in hydrogen storage, thanks to its long-time expertise as world leader in gasoline tanks

The first stage in the production process is manufacturing the vessel by plastic blow molding, a technique Plastic Omnium has long experience in.

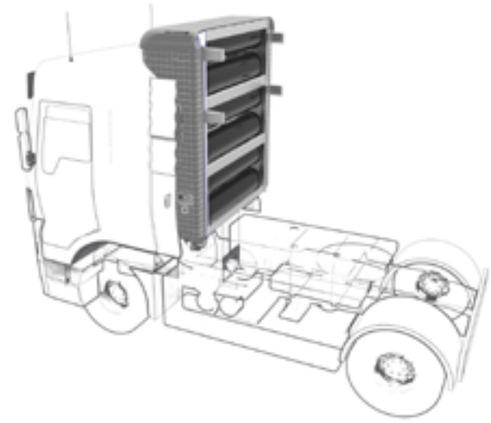


The plastic vessel is then wrapped in resin-impregnated carbon fiber to form the vessel's mechanical casing. Using a technique similar to weaving, the winding is produced by crisscrossing carbon fibers uniformly over the entire vessel. Plastic Omnium is also the driving force behind Composicad©, a software package widely used by hydrogen vessels manufacturers around the world for scaling and optimizing the filament-wrapping process.

Plastic Omnium can leverage its industrial capacity to mass produce its technologies in series. Managing production is Plastic Omnium's day-to-day business.

Plastic Omnium can keep America's big trucks moving with hydrogen

It takes a large amount of hydrogen stored in 400-liter vessels to keep a big truck on the road. Plastic blow-molding is the best current technology for producing tanks of this capacity at scale. And Plastic Omnium is the only company that has combined expertise in blow-molding and the filament-wrapping process. This is a clear edge for the Group.



The USA has earmarked seven billion dollars for developing hydrogen hubs around the country.

In September 2022, the department of energy invited applications for a project to establish regional green hydrogen hubs (H2Hubs) in the USA. The aim? To create large-scale hydrogen ecosystem in key economic regions across the country.

California leads the way: with backing from several other states and the California Air Resources Board, it is demanding that 50% of new medium and heavy trucks sold must be zero carbon emission by 2030. This measure will be progressively rolled out from 2024, which will encourage the main truck makers on the market to find solutions.

Plastic Omnium presents its fuel cell system for trucks, buses and trains

This is where it all happens. As its name suggest, the fuel cell system comprises a fuel cell and all the ancillary components needed to make it work.

HOW IT WORKS

- **The fuel cell acts as the vehicle's power plant,** producing electricity that powers the electric motor. It uses a chemical process to combine hydrogen and oxygen in the air to produce electricity, emitting nothing more than water and heat.
- **The surrounding system comprises over 160 separate components** that provide vital additional functions, such as thermal control, electronic management, compressed air, humidity control and voltage conversion.

The heavy truck implementation presented on its stand showcases **Plastic Omnium's mastery of highly compact formats**: 160 are fitted in the limited space around the fuel cell, with optimized design, integration, durability and reliability.

Fuel cells: a technology introduced to Plastic Omnium's product line-up with the EKPO joint venture

Plastic Omnium and ElringKlinger set up a joint venture called EKPO Fuel Cell Technologies in March 2021. EKPO offers a full range of fuel cells, with power levels from 10kW to 205kW, that comply with automotive industry standards and cover all types of applications, from cars, commercial vehicles, buses and trucks to boats, trains and aircraft.

Plastic Omnium investing in hydrogen

Plastic Omnium is convinced that hydrogen will play a major role in the clean mobility of the future. It has invested over €300 million since 2015 to increase its expertise and industrial footprint across the entire hydrogen value chain. The Group forecasts that it will invest an additional €100 million each year in average as it targets revenue of €300 million in 2025 and €3 billion by 2030.

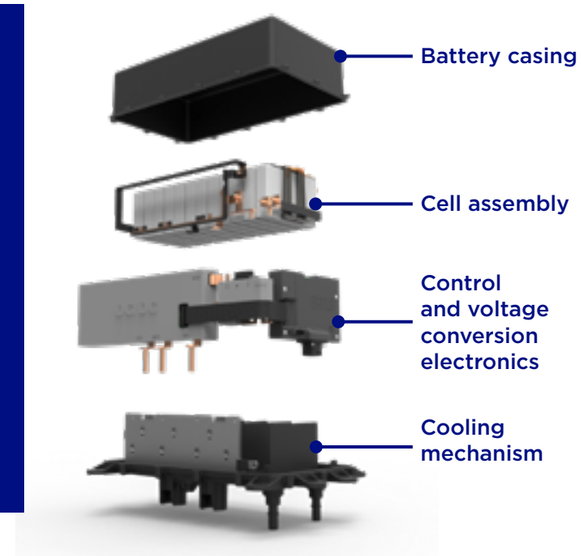
III. Plastic Omnium presents its expertise in battery systems

Plastic Omnium is emerging as a supplier of onboard mobility battery systems. It designs its electrification solutions holistically: Plastic Omnium does not advocate any particular electromechanical package, meaning it is able to meet the needs of a highly diverse range of customers, in accordance with their specific applications.

Plastic Omnium, expertise in battery solutions for mobility

In 2022, Plastic Omnium took a further step toward its mobility decarbonization strategy with the creation of a new line of E-power products offered by its Clean Energy Systems division, developing power electronics solutions and onboard battery systems for hybrid and all-electric vehicles. The medium-term target? All forms of mobility applications, from car to truck and bus, and all types of electrified industrial vehicles.

Today, Plastic Omnium's line-up of battery products is aimed mainly at heavy vehicles, buses and trucks requiring high-voltage batteries. But it also provides products for cars with 48V batteries.



Plastic Omnium defines and assembles battery packs by integrating electrochemical components (the cells at the heart of batteries) from different partners, such as disruptive sodium-based solutions from startup Tiamat, and more conventional lithium cells. **The Group is agnostic to the electrochemistry used**: Sodium-ion or Lithium-ion, Plastic Omnium knows how to construct the battery pack as well as the electronics for management.

Plastic Omnium's added-value? Its excellence as a pack maker. Plastic Omnium builds the system around the cells, the electronics, thermal control and mechanical assemblies. In other words, it assembles various modules around the cells to create a battery system. What it delivers is more than just a product; it delivers complete solutions, leveraging its industrial expertise to provide the market with the best technologies at the best price.

Plastic Omnium aims to provide twin products: a power battery line for mild hybrid vehicles and an energy battery line for 100%-electric vehicles.

The key lies in how the cell is integrated into the battery system. Plastic Omnium plays a central role as a systems specialist.

Plastic Omnium incorporates the latest wide-bandgap semiconductor technologies to improve vehicle efficiency.

Why is Plastic Omnium entering the battery market?

Today, the vast majority of automotive batteries are developed in collaboration with electromechanical cell manufacturers by automakers that have, for the most part, integrated battery packaging directly into their skills. With its long industrial and technical track record in onboard energy storage for vehicles, Plastic Omnium believes that, in the future, growing demand will require automakers to team up with tier 1 suppliers for the rollout of their electric vehicle ranges. Plastic Omnium is preparing for this future scenario and highlighting its role as a systems specialist.

Plastic Omnium, a battery and hydrogen systems specialist. Plastic Omnium is highlighting its role as a systems specialist to deliver complete solutions for battery electric vehicles as well as hydrogen electric vehicles. For hydrogen electric vehicles, Plastic Omnium supplies the battery, tanks, fuels cells and the complete system. For battery electric vehicles, Plastic Omnium supplies the complete battery system and the power electronics components.

Offering a comprehensive system incorporating electronics and power electronics. Plastic Omnium's expertise as a systems specialist also extends to key electronics technologies. Voltage converters adapt the 400V-800V of the battery to the 12V-24V needed by a vehicle's onboard network. They fill a bidirectional voltage conversion role. In hydrogen vehicles, they step up the voltage from the fuel cell to match the battery voltage. Inverters transform direct current from the battery to an alternating current to power the electric motor.

Some technical background

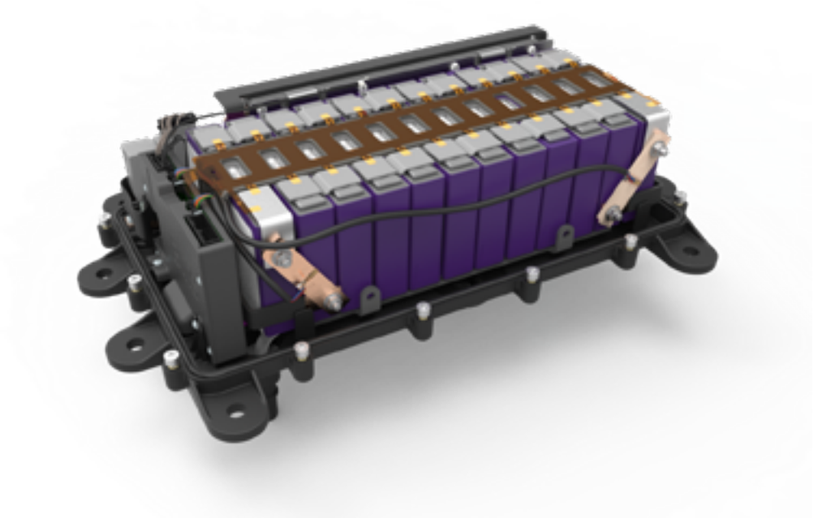
In a hydrogen car, the electric motor is usually powered by a hybrid system comprising a fuel cell and an auxiliary battery. The battery assists the fuel cell when the electric motor transitions to peak power phases, optimizing onboard energy management. This helps protect the efficiency and durability of the fuel cell. The fuel cell then takes over to produce the electricity needed to operate the motor. The battery recharges itself by recovering energy during braking, which further extends the vehicle's range.

Plastic Omnium exhibits its high-voltage 48V battery created with its partner Tiamat

Plastic Omnium is using a disruptive sodium-ion electrochemical technology from French startup Tiamat to develop tomorrow's power battery packs. By partnering with Tiamat, Plastic Omnium is championing a product of the future with the aim of developing high-power 48V battery systems for mild hybrid, hybrid and hydrogen vehicles.

TIAMAT

Tiamat offers a unique solution using a raw material widely available around the world to produce batteries with no lithium, nickel or cobalt, meaning they are not reliant on supplies from other parts of the world.



Tiamat develops batteries based on sodium-ion

The electrification of mobility is happening now, driven by stricter regulations and people's determination to act in the face of the climate crisis. This leads to a vast need for energy storage: 4,500GW in 2030 worldwide. In 2022, energy storage needs amounted to just 400GW (source McKinsey).

This situation points to an unarguable conclusion: there may be future shortages of the main raw materials needed to manufacture batteries — lithium, nickel and cobalt — despite current initiatives to increase extraction, refining, synthesizing and recycling capacities.

Meeting this growing demand for energy storage will mean turning to battery solutions based on alternative resources that are not reliant on raw materials potentially in short supply.

Sodium-ion, a solution for power batteries

One of the many technological advantages of sodium-ion is ease of insertion and removal from the active electrode material, which gives it outstanding power density and charging times. This inherent performance is of particular interest for automotive hybridization applications, where the primary need is not for range but for power during acceleration or energy recovery under braking. The battery acts as a booster for the electric motor during acceleration and reduces the amount of fuel used.

Tiamat has developed a sodium-ion battery able to absorb and deliver a high amount of current in a very short period.

How does a battery work?

The idea behind a battery is that electrons circulate and create a difference in potential between the two electrodes, negative and positive, that are immersed in an ion-conducting liquid called an electrolyte.

A battery consists of positive active material and negative active material. When current is applied to the positive active material, this generates ions that progressively migrate to the negative active material, which acts a little like a sponge. When the battery provides power to a device, the electrons accumulated in the negative electrode travel via an external electrical circuit to the positive electrode: this is the discharge phase. Conversely, when the battery is charging, energy from the charger returns the electrons back from the positive electrode to the negative one.

The sodium-ion battery from Tiamat: significant advantages

Tiamat offers a power battery product with an ultra-rapid charge time: from 0% to 100% charge in 10 minutes. This makes it possible to manufacture small, lightweight battery packs with longer service lives and with better safety conditions than anything else currently on the market. It also guarantees a fully secure supply chain.

Tiamat's battery: unrivalled safety

Sodium-ion batteries are very safe batteries: if a battery overheats and the temperature rises above a certain level, thermal runaway is limited to no more than 200°C, a temperature low enough to avoid the runaway propagating to adjacent cells.

What are the benefits? The ability to make battery packs using lighter plastics and with simplified safety mechanisms. This ultimately means a battery pack with lower weight, lower cost and higher energy density!!

Hydrogen vehicles need an auxiliary battery as well as the fuel cell. And the Tiamat sodium-ion battery is ideal for use in hydrogen vehicles: it provides considerable power during acceleration and can recover energy easily under braking.

Why was sodium not used to produce batteries from the outset?

In the 1990s, sodium and lithium competed head-to-head in the race to perfect ion-exchange batteries. There was a major drawback with sodium-ion: because the batteries were bigger and heavier, they delivered less energy density and, therefore, shorter range. Lithium-ion was better placed to deliver greater energy density.

Back in the days when all the efforts focused on lithium, researchers with France's National Center for Scientific Research (CNRS) had a hunch and continued their work on sodium-ion technology, sensing that there was perhaps a place for sodium in the future. Their gamble paid off, resulting in supply chain independence and sovereignty.

IV. Plastic Omnium launches a new generation of mobility lighting

In 2022, Plastic Omnium set up a new Lighting division. The division uses advanced materials and software to develop lighting solutions that offer far greater design freedom, quality services and driver assistance. From conventional solutions, such as headlights and signal lighting, to high-tech, high-performance products, Plastic Omnium offers a 360° product for a safer, more sustainable and unique travel experience.

Two of its latest product solutions are now honored with the CES 2023 Innovation Award: both the *Dynamic Welcome Light Projection* as well as the *Intelligent Off-Road Mobility Lighting System* have won in the "Vehicle Tech & Advanced Mobility" category.

Plastic Omnium showcases its CES Innovation Award-winning Dynamic Welcome Light Projection

Plastic Omnium's Dynamic Welcome Light Projection greets a vehicle's driver and passengers with an animated image projected onto the ground as they approach the vehicle. The module can be fitted to the vehicle sill panel as well as around the entire vehicle. It's based on a Microlens Array (MLA), a lens system which projects four different graphics independently from a single unit, thus enabling partial or full surround projection of all kinds of light patterns including warning symbols.

This is the first projection module in the world to use a microlens system for non-static lighting on the ground next to a vehicle.

More stylish. Plastic Omnium's Dynamic Welcome Light Projection system makes it possible to use unique dynamic lighting displays to welcome drivers and passengers. OEMs and end customers gain more customization options through enhanced branding and communication.

Safer. The system also provides greater safety by not only illuminating the vehicle entrance, but also projecting warning symbols in front of the driver's and passenger's doors – for example a snowflake in case of icy conditions.

Already developing the next stage: Digital projection solutions

Plastic Omnium is already developing a new generation of projections that can feature not only animated images, but also on-demand video content. The Group's digital projection solutions take interior and exterior customization to the next level by displaying customized content. In addition to a completely new vehicle design, this opens up a whole new market for OEMs in content management for innovative experiences.

Images projected onto the ground can be updated in real time via smartphone. This is a real breakthrough for dynamic projections, which were previously limited to standard images preloaded into the vehicle.

The possibilities offered by digital projections transform the vehicle's surroundings into an interactive canvas that can be used for appealing and functional light scenarios.

DMD: central to digital projections

A Digital Micromirror Device (DMD) is an efficient optical system comprising high-performance LEDs, the DMD itself and the associated electronics, including the software and components needed to control the system. Its high level precision improves contrast and minimizes stray light and phantom images. These are small modules that can be fitted all over the car, inside as well as outside.

Safe driving off-roads thanks to the awarded Intelligent Off-Road Lighting System

The popularity and sales of off-road vehicles has risen since COVID-19, as have the number of accidents involving them. Research shows that at least 40% of off-road accidents happen at night. The smart off-road lighting system from Plastic Omnium helps drivers to use their vehicle more regularly and in greater safety.

The intelligent lighting system predicts precise lighting needs and creates an accurate beam to ensure the right light, in the right place, at the right time.

The system does more than just provide a 300% boost in baseline lighting performance; it also adds adaptive driving modes and offers ready-to-use auxiliary lighting modules delivering greater safety, customization, and added value to end-users.

Intelligent lighting: at the heart of the system

The system includes the patent-pending multifunction projection unit that uses an array of individually controllable LED light pixels which enable several lighting modes. Using data fusion, the system processes internal signals such as the acceleration and steering of the vehicle together with external data such as GPS to seamlessly adapt the illumination of the chosen path.

This lighting system is compatible with a wide range of off-road vehicles: SxS and UTVs, quads, snowmobiles and two-wheelers.

Further expanding the possibilities for vehicle lighting: Front & Signal Lighting Innovations

Plastic Omnium is already developing new innovations for front and signal lighting: Micro-LED projection modules, for example, combine intelligent front lighting with semi-HD projections of a light patterns in front of a vehicle and onto the road.

The options range from road projections of speed limits, navigation arrows to lane guidance in narrow spaces – for more assistance to the driver and more safety.

In signal lighting, Surface LEDs are the latest innovation. The patented technology combines an ultra-homogenous OLED look with all the advantages of classic LED light guides: They have a particularly thin design, support multi-color and 3D lighting, and are cheaper to manufacture while lasting longer. Plastic Omnium's latest development "ILLUVISION" combines profound lighting expertise with know-how in advanced manufacturing technologies and marks a milestone for the group's LED family, further increasing design freedom.

V. Plastic Omnium presents increasingly customizable modules in line with new usages and helps users' daily lives

Vehicle electrification is opening up new opportunities for Plastic Omnium as it continues to increase the added-value it offers. New vehicle architectures bring with them new functions and possibilities for innovating and creating new modules.

Plastic Omnium's watchword is to put itself in the user's shoes in order to offer the best technologies. The Group is showcasing its front trunk – so called "frunk" – and automatic Charge LID, two edifying examples that reflect the strong demand for increasingly customized modules.

Plastic Omnium produces 1-in-5 of all front-end modules worldwide.

Plastic Omnium unveils its intelligent frunk and makes multimodal mobility possible

Plastic Omnium is rethinking the role of the frunk: more than simply a storage space, the front trunk incorporates a series of functions that meet specific needs end-users may have. For example, the front trunk means that people living in the city can make the first stage of their journey by car and charge their electric scooter stored in the front trunk – while driving their car.

HOW IT WORKS

The electric car frees up space under the hood: with the disappearance of engines and batteries fitted under the floor, the space at the front of vehicles is ready to take on new roles. Plastic Omnium, via its HBPO division, the leader in complex modules for vehicles, offers a new use for a new space: a front-trunk module that goes beyond the traditional storage function.

Since there is no longer an engine in an electric vehicle, there is plenty of room. Plastic Omnium has turned the front into a multi-purpose offering.

A front trunk tailor-made to make life easier for users.

Originally, frunks were simply enclosed spaces for storing items. Plastic Omnium takes things to the next level, offering a complete service tailored to specific uses: for campers who want to store a cooling box and fold-up table, for urbanites who want to bring their electric scooter along to travel the last mile, or to recharge their tablet while they drive, and so on. The goal? To offer more added value to the end-user.

Plastic Omnium exhibits a cutaway version of its frunk to reveal the full extent of its complexity.

This is a standalone unit that is inaccessible from inside the vehicle. The frunk is also the clearest of signs that the driver is on board an electric vehicle.

Previously, the frunk was offered to customers as a series of separate elements, not a one-piece solution. Plastic Omnium has created a module that makes it possible to sell a complete ready-to-use solution. Plastic Omnium can rely on the long-standing expertise of its HBPO division in assembling modules of ever greater complexity.

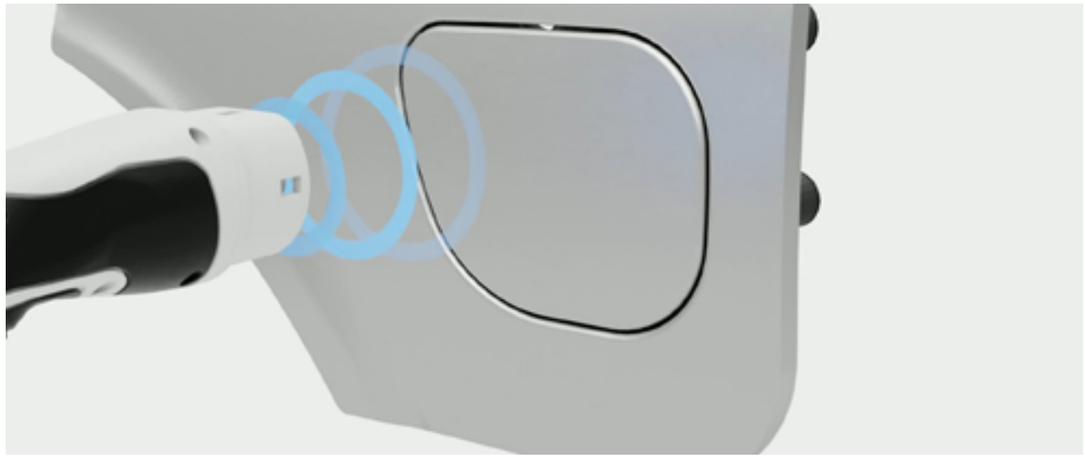
« Plastic Omnium is not inventing the frunk... it is reinventing the module it comes with, offering new services to end-users. »

Which functions can be incorporated?

- Built-in solar panels for energy production
- Inductive charging port for micro-mobility vehicles
- Built-in removable cooling bag
- Primary screen wash system with high-pressure pump for cleaning, sensors, headlights and windshield
- Water refills
- Several storage areas

And much more besides...

The automatic Charge LID: from a gadget to a trend



Plastic Omnium's automatic Charge LID system for electric vehicles offers far more than just charging. Plastic Omnium leverages the long-standing expertise of its HBPO division in assembling modules of ever greater complexity to offer a host of technologies packaged into a single module, including an actuator driven lid door, multiple lighting solutions, charge indicator, de-icing function up to personalized ground projections, etc.

Plastic Omnium is not inventing the Charge LID... it is reinventing the module that accompanies it and thus offering new services to the end-user.

The automatic Charge LID is an important solution that supports the rollout of self-driving vehicles.

Plastic Omnium is adding services inside the Charge LID to offer ever more added value.

- **A necessary solution to support the development of autonomous driving vehicles.** With the development of increasingly autonomous driving, automatic recharging openings are becoming a necessity as no driver will be available.
- **Same for autonomous valet parking solutions**, enabling vehicles to park close to each other, thereby making substantial savings in space and investment. Also here, automatic charging solutions will be a necessity
- **Plastic Omnium integrates lighting** in its module to guide the user when inserting the recharge. Very useful in night conditions!
- Plastic Omnium integrates **a defrosting function of the opening lid by vibration**. The actuator is then powerful enough to open the door. A situation that is not uncommon in cold countries!
- **A comfortable solution**: with it, there is no need to open the door by pushing or pulling. The door opens automatically via a mobile application, a button directly integrated in the car keys or up to a movement recognition.

VI. Plastic Omnium reaches key software milestones

Plastic Omnium has carried out a far-reaching transformation of its product line-up, hand-in-hand with a major increase in the role played by software. This applies particularly to the latest additions to the Plastic Omnium product family: lighting and electrification technologies. Plastic Omnium is moving up a gear as software becomes omnipresent.

Plastic Omnium has set up OP'n Soft, a totally new entity 100% dedicated to software development

Plastic Omnium is redesigning the car for a software-based world where mobility is increasingly electric, connected, autonomous and shared. **The software-defined vehicle is becoming the rule**. Plastic Omnium stands ready to support this trend and offer its advanced expertise.

Op'n Soft is the new nerve center for software at Plastic Omnium. It developed from the realization that the Group is home to a range of related skills such as software architecture, coding, integration and validation testing, that are common to several of its activities.

A growing number of products from Plastic Omnium incorporate software, such as lighting, radar, and fuel cells. What do they all share? Software and electronics. Plastic Omnium ensures that all its products meet software market standards, and uses the strengths of the products in its line-up to offer unique new services.

A key issue for Plastic Omnium is to succeed in combining the radar, bumper and lighting software blocks to offer new services. In use, this means the radar detects an object and then sends the information to the lighting solutions, which act accordingly.

With Op'n Soft, Plastic Omnium has reorganized all its software-related activities to gain ASPICE[1] certification and offer AUTOSAR[2] platforms that make access to plug-and-play components easier for its customers.

Headquartered in Paris, Op'n Soft will be a key asset for Plastic Omnium as it enters the automotive software market and develops new services and products.

[1] ASPICE (Automotive SPICE) is a standardized framework for assessing an organization's ability to deliver software products effectively and reliably.
[2] AUTOSAR (AUTomotive Open System ARchitecture) is a worldwide development partnership of vehicle manufacturers, suppliers, service providers and companies from the automotive electronics, semiconductor and software industry.

Plastic Omnium consolidates its onboard software skill-sets and forges new alliances. Close-up on the partnership with startup Alkalee

Plastic Omnium uses open innovation to tackle these technological transformations and prepare to meet the challenge of the shift to software. Plastic Omnium partners with startups and deep-techs as part of its approach based on long-term thinking, positioning itself far ahead of the changes in today's technologies, and devising disruptive new innovations.

In teaming up with Greenerwave, Plastic Omnium is paving the way for transferring telecommunications technologies to the automotive universe.

With Tiamat, Plastic Omnium is exploring the new chemistry of sodium-based batteries.

With Alkalee, Plastic Omnium is ramping up its know-how and knowledge of software-defined vehicles.

Plastic Omnium has forged its first alliances and projects a major acceleration of its open innovation strategy in the coming years.

The vehicle of today has little in common with its 20th-century ancestor: software is now omnipresent, ushering in a total overhaul of the functions and possibilities the car offers.

Smarter, connected and autonomous: over the years cars have steadily offered an increasing number of functions of ever greater complexity: the car of today includes a hundred or so tiny interconnected onboard controllers (ECUs), similar to computers, each running one specific function.

The car of tomorrow will be more complex still, and adding more ECUs to run each function will no longer be desirable, neither economically, nor in terms of making sure that vehicles are repairable. This system is fast becoming too cumbersome and too complex. Which is why cars need to be completely rethought. This is the purpose of the software-defined vehicle, designing a vehicle around the software instead of around the mechanical components.

Building a software-designed vehicle requires tools that are highly efficient and secure. This is the added-value that Alkalee offers: supplying a software solution that guarantees applications are seamlessly integrated into a high-power, single central computer.

Alkalee makes it possible to integrate Plastic Omnium's software applications with automakers.

Do we really need 100 ECUs to manage 100 functions?

Would it not be possible to have just one ECU to manage all of a car's functions? This is the goal of the software-defined vehicle: developing and perfecting centralized electronics able to control all the vehicle's functions. Basically, a type of super-computer that handles everything!

This means that all onboard software, everything from sunroof to air-conditioning and the autonomous driving radar will operate via a single ECU. This is highly complex to implement, and no current vehicle has a wide variety of disparate functions running via a single super-computer.

Plastic Omnium's applications have a growing amount of intelligence built in, covering lighting, battery control systems, hydrogen fuel cells and 4D radar. Each of these applications has to be compatible with automakers' software environments so that they can integrate them easily, quickly and without the need for any additional development work.

Plastic Omnium and automakers must speak the same language. Alkalee acts as a translator.

Alkalee's mission is to develop a high-performance software interface that makes it easy to securely integrate new applications into a vehicle, with a particular emphasis on cybersecurity. In other words, working with Alkalee allows Plastic Omnium to develop applications that can be provided via any automaker's app store (just like for smartphones).

Exactly like when you plug a device into a computer, the device needs to be recognized quickly. The integration of new applications must not place any additional demands on the manufacturer's software ecosystem.

What is important to customers is the application itself. How exactly the application integrates into vehicles is a task handled by Alkalee and Plastic Omnium.

Alkalee helps different worlds to interconnect: Alkalee uses advanced mathematics to make secure communication possible between the world of Plastic Omnium and the world of the automakers.

Synchronization and speed: the two keywords.

- Unlike smartphones, a car is required to keep its occupants safe and to take the right decisions at the right time. The concept of "at the right time" is fundamental: if a self-driving car decides to take an off-ramp, everything must happen at the right time if it is not to turn 10 meters too early or 10 meters too late.
- The concepts of real time and reactivity are unknown to a smartphone: when you launch a Google search, your smartphone may give you an answer in a second or 10 seconds, without this posing any risk to you.
- But when it comes to mobility, real-time management is fundamental because the danger is real: Alkalee provides this management and security in operation, right the way from design stage to user rollout.

Plastic Omnium in brief

9 billion euros
pro-forma revenue in 2021

A **leading position** in each of its traditional business lines

93 automotive customer brands

150 plants

and **43** R&D centers

37,000 employees

18 million fuel emission reduction systems produced every year, representing **1-in-4** produced worldwide

22 million dproduced every year representing **1-in-6** produced worldwide

About Plastic Omnium

Plastic Omnium has supported change in the automotive industry for the past 75 years. Plastic Omnium is leveraging its entrepreneurial spirit and innovation-led culture to design and produce complex and interactive body systems, systems for emission reduction and energy storage, and complete lighting solutions. Sustained investments in hydrogen since 2015 have developed a comprehensive range of hydrogen storage vessels, fuel cells and systems. These assets and innovations position Plastic Omnium as a partner of choice for every stakeholder in zero-emission mobility.

With pro forma economic revenue of €9 billion in 2021, a global network of 150 plants and 43 R&D centers located close to its customers, the 37,000 women and men of Plastic Omnium are committed to meeting the challenges of net-zero mobility.

Plastic Omnium is listed on Euronext Paris, compartment A. It is eligible for the Deferred Settlement Service (SRD) and is part of the SBF 120 and CAC Mid 60 indices (ISIN code: FR0000124570).
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