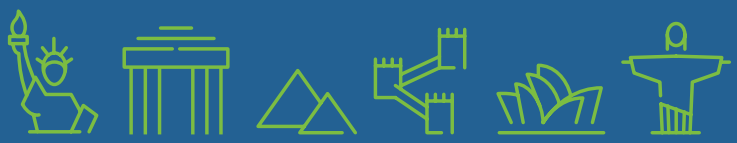
INNOVATIVE, SUSTAINABLE EXPERTISE
AUTOMOTIVE SOLUTIONS
TO DRIVE MOBILITY

AUTOMOTIVE CAPABILITIES AT A GLANCE

MKS is a global market leader in electroplating, equipment, chemistry and service



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With sales into approximately 100 countries, MKS is the approved choice of industry-leaders worldwide. You can expect nothing less than first- class service and customer support

Green technologies
We reduce our carbon footprint, use less hazardous chemicals, and eliminate waste water to the greatest extent possible

Automotive competence
Underlined by a unique automotive industry approach with reliable, high-quality processes, equipment and chemistry for the entire spectrum

Leading technologies
R&D is the backbone of our success. We regularly work directly with end customers and OEMs to co-develop new ideas that drive product innovation

Production know-how
Paired with our broad production know-how, our highly skilled personnel and manufacturing capabilities make us the trusted partner within our industry

Customer focus
Our outstanding team of highly qualified plating experts is dedicated to ensuring that our customers achieve their goals

Collaboration
We collaborate extensively with the entire value chain to seek new paths and set bench-marks for the development of innovative processes

Patents
Over 4,000 patents worldwide

Materials and photonics solutions for a mobile tomorrow that is more sustainable, sophisticated and intelligent than ever.

The tightening of CO_2 regulations and the introduction of sustainability roadmaps are leading to an increase in vehicles with alternative drive systems and a focus on sustainable materials and products throughout the automotive supply chain. At the same time, connectivity and autonomous technologies will increasingly continue to transform the car into a platform where both drivers and passengers can experience an array of new features and services while on the road

Sustainable transformation

Driven by legislation and broader social debates, automotive manufacturers are reducing their carbon footprint in both production and vehicle emissions. The use of alternative drive systems and lightweight construction play an important role in this process. The rapidly advancing development of alternative drive systems is paving the way for low-emission mobility as well as new technologies and advanced materials. At the same time, growing environmental awareness is driving not only the demand for net-zero technologies and recyclable vehicle components, but also new, advanced mobility concepts, such as car sharing. This results in the increased use of individual vehicles, which therefore require longer service lives and components with higher wear and corrosion resistance. Meanwhile, sustainable value chains are becoming increasingly important, with a focus on reusing and recycling resources and eliminating the need for hazardous substances.

Autonomous driving and safety

The future-oriented trend towards autonomous driving, which is associated with more than just e-mobility, has an impact on powertrains of all kinds. In combination with connectivity, new technologies ensure the safety of cars and their occupants, providing the features necessary for the effective control of energy consumption. In the future, digital technologies that enhance both safety and connectivity from machine to human, machine to machine, and machine to x, and that are reliable, fault-tolerant, and robust will take the wheel.

The less human influence is required for a vehicle's mobility, the more passengers will perceive cars as radical shifts from the norm, which will, in turn, increase the amount of time they'll want to spend enjoying the ride. For this reason, emphasis will increasingly be placed on in-vehicle information and entertainment features, as well as interior design.

Industry expertise

As a long standing and reliable partner to the automotive industry, MKS Instruments has a deep understanding of the requirements of automotive manufacturers and their suppliers. With our profound expertise in decorative and functional surface finishing solutions, Lidar and night vision sensors and optics, laser beam measurement and characterization products, we enable our customers to meet the demanding innovation, performance and quality requirements of the automotive industry. So, whether it's providing the right surface finishes for new car exterior and interior materials, or ensuring more comfort, safety and entertainment, we help complete the driving experience.

About MKS Instruments

At MKS, we have a long history of leveraging our collective curiosity to understand and develop solutions that are at the core of many key technological innovations. These innovations have driven accelerated roadmaps for the markets we serve. Our mission is to be the innovation leader and trusted partner that pushes the boundaries of possibility.

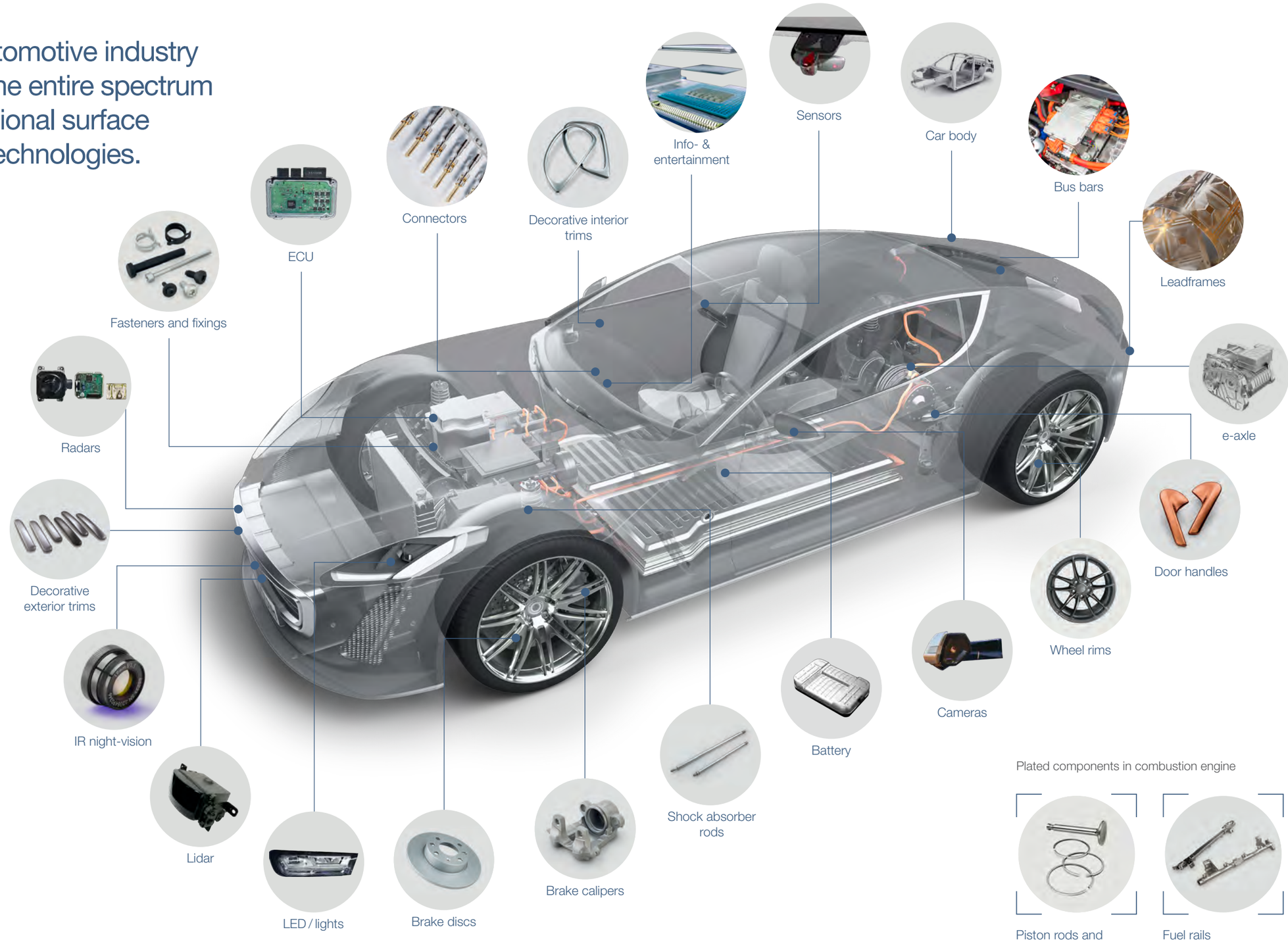
We are organized into three divisions. Our Vacuum Solutions Division is derived from our core competencies in pressure and flow measurement and control, gas composition, gas delivery and analysis, reactive gas generation, electronic control technology, power generation, and vacuum technology.

Spectra-Physics®, Ophir®, Newport™ and ESI are brands within our Photonics Solutions Division providing a full range of solutions including lasers for precision industrial and scientific research, laser and LED measurement, beam profiling, precision motion control, optical tables and vibration isolation systems, photonics instruments, temperature sensing, opto-mechanical components, optical elements, and systems for flexible PCB laser processing, high-speed MLCC testing, and CO_2-laser-based systems for HDI PCB and IC substrate manufacturing.

Atotech, a brand within the Materials Solutions Division, develops leading process and manufacturing technologies for advanced surface modification, electroless and electrolytic plating, and surface finishing. The Atotech portfolio includes chemistry, equipment, software, and services for innovative and high-technology applications in a wide variety of end-markets.

MKS AUTOMOTIVE SOLUTIONS

Our portfolio for the automotive industry includes solutions for the entire spectrum of decorative and functional surface treatment for all drive technologies.



Decorative coatings

Plastic pre-treatment
Copper/nickel/chrome coatings

Wear resistant coatings

Functional chrome coatings
Electroless nickel coatings

Corrosion protection coatings

Zinc and zinc alloy coatings
Zinc flake coatings

Paint support technologies

Paint overspray treatment, pretreatment, stripping

Electronics

Wet chemicals and production technologies for printed circuit boards, semiconductors and functional electronics

BODY

Paintwork

Transitioning away from solvent-based paints requires implementing more environmentally friendly waterborne paints, which can lead to foaming and unpleasant odors due to elevated concentrations of organics and biochemical oxygen demand (BOD). MKS' Atotech paint overspray technology offers the ideal solution for treating waterborne and solvent-based paints, as well as mixed paint systems for superior, simplified treatment with improved sludge reduction. Our product range also includes a sustainable in-house paint removal alternative.

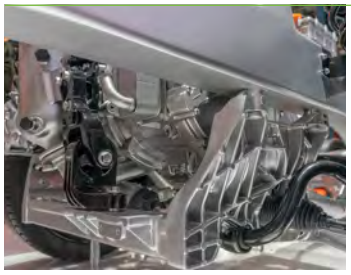
Wheels

For cast and forged wheels, MKS has developed long-life, low-temperature cleaners that reduce the amount of water and energy required to remove organic and inorganic soils, as well as zirconium conversion coatings that provide a corrosion-resistant barrier and improve paint adhesion. Wheel bolts – mounted multiple times and exposed to harsh road conditions – require the stable friction values provided by our coating systems, which include alkaline zinc nickel electrolytes, passivates, and zinc flake technology (topcoats).

Welding and brazing

In the body-in-white stage, laser cells are commonly used for joining parts with welding or brazing. Ensuring the strength of the joint is crucial to avoid any issues further down the production line that could lead to more rejects and cost-intensive rework, particularly in visible areas. MKS has developed measurement technologies dedicated for use in automated laser cells such as our Ophir power measurement systems, modular IPM device, or integrated beam analyzer. Measurements of high-power lasers in the kilowatt range are taken in fractions of a second to check the beam parameters and avoid rejects.

CHASSIS



Aluminum parts

Lightweighting encourages the use of aluminum parts that require surface treatment and corrosion protection to extend the vehicle's service life. Our Atotech sustainable pretreatment solutions, including low-temperature cleaning, nitric acid-free activation and aluminum passivation, provide a superior approach to creating a durable, corrosion resistant coating for underbody and structural components. Our sustainable paint removal processes also preserve the substrate's structural integrity for high-value part reclamation.

Fasteners and fixtures

The fasteners and fixtures connecting structural components must meet increasing durability standards. Our sustainable, innovative corrosion protection systems include zinc, zinc nickel, zinc iron electrolytes, passivates, and lubricated sealers, as well as zinc flake systems that combine a base and lubricated topcoat. All systems exhibit outstanding corrosion protection with defined coefficient of friction windows, fulfill requirements for color stability and multiple mounting on a range of materials and have wide OEM standard approval.

Shock absorbers

Countering the subtle deterioration caused by constant action and fluid friction, shock absorber rods require very high wear resistance to maintain the safe roadability of a car. MKS offers hard chrome solutions that provide excellent wear resistance and corrosion protection for shock absorber rods. Combining high-performance process chemistry and plating line technology, our Atotech system has revolutionized shock absorber rod plating. The result is excellent quality and flexibility that offers environmental, economic, and resource benefits.

Brakes

A properly functioning brake system is essential. Components are exposed to harsh road environments and prone to corrosion. MKS' acid zinc and zinc nickel processes provide the highest possible corrosion protection and chemical resistance for brake calipers and pad backing plates. Our zinc flake coating systems prolong the service life of brake discs and drums and ensure continued safety. Trivalent hard chrome plating solutions and mid-phosphorus electroless nickel processes provide corrosion protection and wear resistance for brake pistons.

Mounting frames and arms

In spite of exposure to loose stones, water, and de-icing salt, engine mounting frames and suspension arms must not deteriorate or lose stability and load-bearing capacity. MKS' innovative finishes, including zinc flake coatings for complex frame structures, exhibit excellent stone-chipping resistance and corrosion protection. Our sustainable paint pretreatments, used in conjunction with our acid zinc nickel systems, yield minimized contact corrosion, a requisite for parts like connecting rods and axle handlebars.

POWERTRAINS

Internal Combustion Engine (ICE) vehicles

For highly stressed internal combustion engine parts such as piston rods and piston rings, MKS' leading hard chrome technologies provide excellent wear resistance and a high level of corrosion protection. Likewise, our medium phosphorus electroless nickel coatings provide a similar level of corrosion protection and wear resistance for moving transmission parts such as shafts and forks.

MKS' range of electrolytic-deposited zinc and zinc alloy coatings as well as zinc flake coating technologies offers excellent corrosion protection and stability for applications exposed to constant high temperatures. The same level of corrosion resistance, combined with a defined coefficient of friction, is provided by our environmentally friendly fastener coating systems, which also fulfill multiple mounting demands on various materials.

Our trivalent chromium decorative coatings lend a sleek metallic look to exhaust pipes and offer a wide range of colors for car concepts of all kinds.

Attention paid to improving the power-to-weight ratio and reducing wear and tear have led to the optimization of differential gears. In turn, ever more bolted joints have been replaced by laser welds. Essential to ensuring the quality of these welds is knowing the key parameters of the laser beam. But time is money, and—at least with traditional methods—measuring a high-power laser could take up to half an hour and require complex, heavy-duty measurement equipment. Implementing our Ophir integrated industrial measurement solution within the automated manufacturing cycle ensures the welding process' quality and stability.

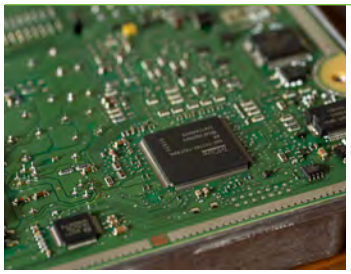
In order to machine the critical features of fuel injector nozzles used in diesel engines, our Newport precision motion products are used.

Electric vehicles

For electric powertrains, ensuring that the e-axle functions flawlessly requires surfaces to be free of defects. MKS offers sustainable long life, low temperature Atotech cleaning solutions for thorough cleaning, as well as phosphate-free coating pretreatments that yield improved paint adhesion. Our sustainable Atotech paint removal processes not only facilitate in-house solutions for fast component reclamation, but support environmentally friendly production in the process. MKS gas analyzers are used to detect and speciate emissions from lithium-ion batteries to ensure the quality and make them safer.

Fuel cell vehicles

MKS has developed high corrosion resistant electroless nickel plating solutions for hydrogen fuel cell-focused applications, specifically for cells, pipes, and hydrogen diffusion barriers where hydrophobic surfaces are needed. Our zinc nickel electrolytes provide corrosion protection to bipolar plates and pipes, as well as to fasteners and fixtures that require a high corrosion performance level combined with a defined coefficient of friction.

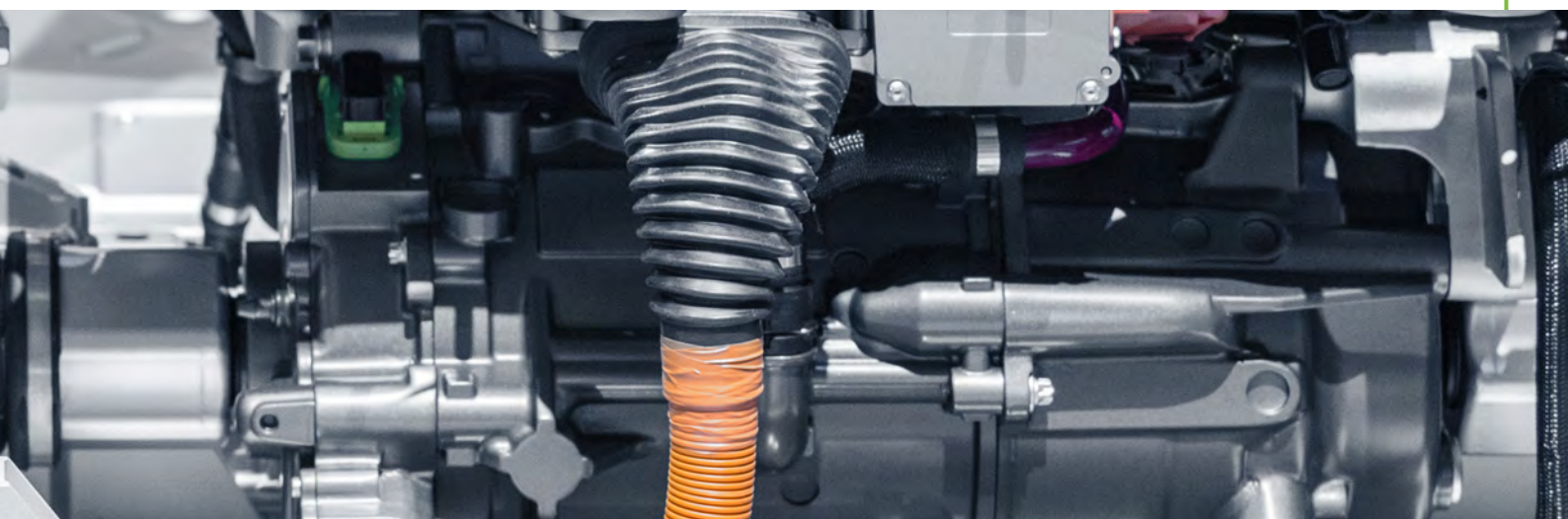


Engine control unit (ECU)

The ECU is the heart of the automobile's modern engine control system. The electronic components within the ECU need to be highly reliable and heat resistant while simultaneously increasing engine performance. MKS offers products that can endure heat and high voltage while maintaining high reliability. These include extremely reliable electroless and electrolytic Cu solutions for HL count and HDI any-layer PCBs, which provide excellent Cu to Cu inter-connectivity and signal transmission, even under severe thermal shock conditions.

Bus bars and connectors

Reliability is paramount for bus bars and connectors. Electrical connections, be they bolted bus bars, press fits, or spring contacts need to withstand tough environmental conditions like high temperatures, humidity, and vibration without losing their excellent electrical conductivity. MKS offers a variety of surface finishes from tin to hard gold deposits that meet exactly these needs: tin deposits with low whisker propensity for press fits, wear-resistant hard gold deposits for connectors with low abrasion and high reliability, and anti-tarnishes that preserve layer properties like conductivity, solderability, and more.



BATTERIES FOR ELECTRO AND HYBRID VEHICLES

Battery cell

Battery electrode foils

EV battery composition includes anode, cathode, and separator foils, each of which must be cut to exacting geometries at high speeds and with superior quality. Lasers are an excellent option for reliable, non-contact processing, with no tooling wear to cause process degradation over time. Power levels continue to rise, keeping pace with growing production volumes. MKS' Spectra-Physics industrial OEM laser products, with pulses from short-nanosecond to ultrashort pico- and femtosecond regimes, offer unprecedented flexibility in tailoring the output intensity in time, enabling high-throughput manufacturing of resilient, high-performance batteries.

Connectors and busbars

Connectors and busbars transmit high current loads and resist attrition caused by permanent motion during a journey. Therefore, high conductivity and wear resistance are essential. MKS is a leading supplier of nickel silver and nickel tin plating processes, as well as anti-tarnishes for connectors and bus bars. We offer complete processes from pretreatment, to nickel barrier and subsequent hard silver plating, to Cr(III) based layers for protection and, alternately, from pretreatment, to nickel barrier and subsequent MSA-based pure tin plating, to heat and humidity resisting anti-tarnishes.

Anode lead tabs

Perfect sealing is necessary to prevent the formation or emergence of hydrofluoric acid. The insulation material must therefore firmly adhere to the anode lead tab. MKS offers the complete coating process, from pretreatment, to nickel processes for barrier layer or conductive layer plating, to the adhesion promoting and corrosion resistant trivalent chromium based top layer for improved adhesion between the insulation and lead tab.

Cathode and anode current collector

Advanced battery technology, especially high-capacity active materials on the current collectors, requires adhesion improvement for the highest reliability through adjusted adhesion promoters. MKS provides adhesion promotion, from tailor made molecules, to formulating adhesion promotion products, to application expertise for the best results in the manufacturing process. Our range of copper and aluminum foil treatments improves adhesion to resins and polyimide.

Thinner copper foils, characterized by lower stress, more even surfaces, and new material combinations for manufacturing current collectors, facilitate weight reduction. Copper plating on top of alternative materials also promotes enhanced conductivity, while surface treatment of the deposited copper layers improves adhesion and corrosion protection.

MKS offers the complete process for copper plating on various base materials, as well as copper surface treatment for corrosion resistance and adhesion promotion.

Battery module

Contact welds

Mass production of battery packs places particularly high demands on laser welding systems. In some cases, over 15,000 welded electrical contacts connect the individual cells. Each one must be of superior quality.

When integrated into the laser welding process, our Ophir laser measurement solution allows fast measurements of the laser power to be taken during loading cycles. While laser power is a good first indicator, for delicate applications where more information is required, more comprehensive measurements can be taken with our non-contact laser measurement solution. The technique exerts no influence whatsoever on the laser beam, nor does the beam affect the device. The laser focus shift can be assessed in fractions of a second, which saves time searching for the root cause of any quality issues. Short measurement time allows for systematic measurements and thus, the tracing of the manufactured parts. Predictive maintenance of laser-based processes leads to a higher asset availability, reduces consumables, and ensures high yields of quality parts.

Battery and cell management

As an integral part of the battery, it is essential that a battery management system has a long lifetime, high reliability, and high productivity. MKS' portfolio of electronic solutions ensures reliability through corrosion resistance and adhesion promotion, efficient power transmission through highly conductive surfaces, and a reduction in weight through the synergy of low-density base materials combined with innovative surface coatings and treatments. These solutions are applicable to virtually all components including wires, bus bars, and lead frames.

Battery housing and fasteners

Battery housings manufactured from aluminum or steel require protection against corrosion. Subsequent coatings, both electrolytic and paint, best adhere to clean surfaces. MKS offers a full range of sustainable cleaners and zirconium based cleaner coaters for battery pack housings.

Steel battery housing components are best protected against corrosion with our high efficiency electrolytic based coatings, which provide unmatched corrosion resistance. With our Atotech electrolytic- and zinc flake-based coatings, fasteners and fixings for battery assembly meet the high demands for reduced contact corrosion and improve conductivity for corrosion performance and defined coefficients of friction.

Electromagnetic shielding

Modern cars include convenience features and safety features. All of these emit and may be affected by electromagnetic radiation-based interference. Electrified vehicles exhibit additional sources, such as power converters, electric motors, traction batteries, or chargers. As source and targets are placed near each other, electromagnetic interference between them needs to be safeguarded by shielding.

For a wide range of applications, MKS offers pre-treatments to plate directly on molding resins for components, PCBs, or highly engineered plastic housings to protect the electronics systems. With our portfolio of highly conductive and soft magnetic electroplated layers, we support high shielding effectiveness for low frequency electromagnetic radiation.

INFO- AND ENTERTAINMENT

Displays

As the car's central control unit, the digital display will become increasingly important in the future. It typically provides links to navigation, entertainment, and various infotainment options. Display design and functionality are becoming more complex, as the industry moves towards displays that are larger, curved, and/or 3D. MKS' Spectra-Physics ultrashort pulse lasers are proven glass-cutting solutions, able to process contoured shapes in a variety of glass types and thicknesses. With a unique architecture offering flexible pulse-tailoring capability, process fine-tuning is possible to accommodate a dynamic form-function environment. Our Newport precision motion products simplify the laser-based machining processes to cut the glass, while tip/tilt stages are used to adjust beam delivery angles for surface coating processing.

At the same time, there is a focus on miniaturization and new display technologies. MKS solutions include electrolytic as well as electroless copper, immersion tin, and ENIG and ENEPIG solutions for printed circuit boards, package substrate, and semiconductor applications.

Touch screens

Touch screen displays need to be reliable and readable in all light conditions. Systems that are easy to use and have quick response times provide access to information directly from the vehicle, other smart devices, and external sources such as smart street cells, objects, and other vehicles via voice connectivity and voice recognition. The displays are often monolithic in nature, with a touch sensor layer integrated with the rest of the display, including those based on organic light emitting diode (OLED) technology, a fast-growing segment of the overall automotive display market. Using our Spectra-Physics ultrashort pulse lasers, with an ultraviolet (UV) wavelength in particular, such assemblies can be cut in variable and contoured shapes, with industry-leading quality and throughput. These systems are vital for safe driving conditions.

MKS' Atotech wet chemical processes enable increased interconnectivity, processing power, and miniaturization via plating solutions for electroless nickel, palladium, gold for ENEPIG and immersion tin, and electroless and electrolytic copper.

Smart surfaces

Smart surfaces combine innovative interior design with functional technologies to create a unique passenger experience. Features are seamlessly integrated into the concept as a whole, enabling practical interaction with controls, lighting, heating, and info display. This creates an aesthetic interior that moves towards a fully autonomous experience. MKS' solution portfolio for flex PCBs, HDI, semiconductor applications, and functional electronics ensures that components run smoothly and effectively. These include ENIG, EPAG, and ENEPIG solutions as well as electroless copper and a range of pre- and post-treatments.

ADVANCED DRIVER ASSISTANCE SYSTEMS (ADAS)

Cameras

The use of vision systems in cars is increasing rapidly. Today, cameras belong to the fastest-growing sensor category in advanced safety. They must comply with the highest reliability standards and offer maximum resolution—a necessity for next-generation autonomy. MKS solutions offer advanced graphite processes for flex PCBs, nickel-gold processes for connectors and bus bars, adhesion promoters, and electrolytic Cu plating for flex-rigid and multilayer PCBs.

Automotive night vision systems use thermal imaging allowing drivers to detect pedestrians and retain a clear view of the road ahead. For maximum performance and minimal collision risk, our Ophir athermalized lenses offer high accuracy in all environmental conditions while also featuring a compact size, and competitive costs.

To assemble the camera, sensor and lens must be aligned in 3D space. This requires the maximum precision achieved by Newport's hexapod motion controller delivering the best focus and image clarity possible.

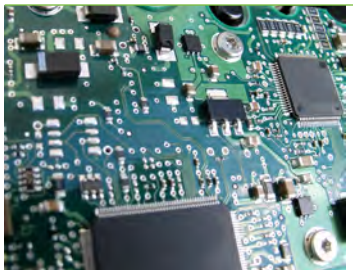
Lidar

Lidar systems for detecting and ranging are one of the fastest developing technologies in automotive advanced safety. Critical for driving safety, these systems have become a next generation requirement to support fully autonomous driving and are often based on vertical-cavity surface-emitting lasers (VCSELs) with a relatively high wattage. To guarantee eye safety and energy efficiency, suitable measurement methods are required. MKS' Ophir integrating sphere power meter is optimized for testing VCSELs and our Newport hexapods are utilized to align the optical components of LiDAR sensors and assemblies. Additionally, our sophisticated Newport motion solutions precisely position the components.

As miniaturization and cost effectiveness are key to Lidar systems, MKS offers solutions for multilayer, flex and HDI PCBs, lead frames, connectors, package substrates, and QFNs. These range from surface treatment, metallization, and copper plating to immersion tin and NiPdAu over EMI shielding solutions and low-roughness solder resist pretreatments.

Radar

Radar systems are another advanced safety feature crucial for the development of fully autonomous driving. From collision warning and blind spot detection to automatic emergency braking, these advanced systems require miniaturization, top-notch reliability, and unique substrates in the hardware. MKS' Atotech advanced graphite and electroless copper solutions as well as our bonding enhancement technologies are just two examples of the dielectric materials needed to achieve the high signal speeds these critical safety systems require.



Central computer

The central computer is the heart of the vehicle of the future. It coordinates car-wide system information and executes commands. Speed, processing power, and reliability are paramount for safety. MKS offers solutions from surface treatment, metallization, and copper plating to immersion tin, nickel-gold and nickel-palladium-gold plating on multilayer, flex and HDI PCBs, lead frames, connectors, and package substrates to ensure these components function reliably and efficiently, while also enabling plating on ever-finer features, key for miniaturization.

LED/ lights

Optimal lighting is a significant factor in ensuring the safety of all road users. Style and sustainability are also increasingly important. MKS offers functional electronic coatings for LED lead frames ranging from anti-tarnishes that prevent brightness degradation for bright acid copper on smooth surfaces to high-speed and high-brightness silver spot plating processes for bright silver deposits. With our Newport precision motion control, the LED source is aligned to the lens assembly and with 6-axis adjustment capability can be performed on a bank of LEDs.

CONNECTIVITY

Over-the-air updates

Connected cars generate data that specifies location, engine status, door lock status, speed, and much more. Information travels both ways thanks to over-the-air (OTA) updates, which means that a car's electronic components can be updated without having to visit a garage. Electronic components such as HDI, MLB and flex PCBs and semiconductors must be highly reliable and have fast response times and ever-increasing functionalities. MKS offers solutions for reliable stacked via buildup, high-purity electrolytic copper for Cu flash and micro via filling, and systems for horizontal electroless and electrolytic copper plating.

Data transfer and communication

Data transfer and communication to other vehicles, surroundings, and the manufacturer is crucial for important features such as emergency assist. A reliable smartphone terminal combining inductive charging, near-field communication, and wireless antenna coupling is also a must. MKS' portfolio includes solutions for manufacturing electronic components for high-voltage devices requiring consistent surface preparation, plating processes, and finishes such as our Atotech immersion tin solutions with high tin thickness and anti-whisker additive or electrolytic and electroless copper processes for reliable copper traces.

Cockpit controller

Thanks to improved software and hardware, as well as increased operational security, the cockpit controller of the future will ensure the rapid, efficient implementation of functions such as voice assistance, real-time information, location-triggered marketing, smartphone integration, and much more. MKS' products ensure increased functionality, quick response time, top-notch reliability, and the potential for further miniaturization. These include our Atotech pre- and post-treatments for better dielectric to copper adhesion, electrolytic tin and tin-silver solutions for HDI, MLB and flex PCBs, IC substrate, sensors, and power chips.

INTERIOR AND EXTERIOR DESIGN

Decorative coatings

MKS' Atotech decorative chrome solutions for plastic and metal-based applications provide durability and attractiveness for heavily used interior and exterior automobile components. Our sustainable series of Cr(VI)-free solutions from plastic pretreatment to nickel plating, plus trivalent chromium decorative coatings and sealers, offer a wide range of colors and designs for matte, satin, or lustrous surfaces, creating cohesive car interior and exterior aesthetics that are in line with established design concepts.

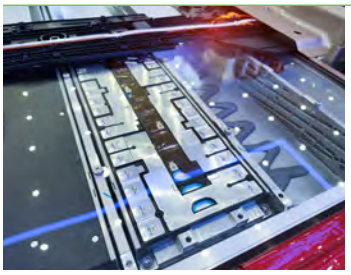
Functional decorative coatings

For automotive interior fasteners, electrolytic deposited coatings and/or zinc flake coating technologies offer both corrosion protection and an attractive appearance. These have small coefficient of friction windows and fulfill complex OEM requirements for functionality and optics. Exterior components exposed to sunlight, rain, and pollution while in frequent motion are best protected with our Atotech electroless nickel coatings, which have excellent wear resistance and corrosion protection, yet preserve streamlined aesthetics.

TESTING

ICE emissions testing

Changing emissions regulations for internal combustion engines drive new engine designs, testing and certification needs. Understanding the compounds found in exhaust gases allows for fine tuning of engine designs, minimizing pollutants and greenhouse gas (GHG) emissions. Bench top testing shortens the iterative engine design cycle. MKS gas analyzers provide engine manufacturers and testers comprehensive insight into exhaust composition ensuring pollutant and GHG regulations are met.



EV battery testing

Lithium-ion batteries are found in today's all electric and plug-in hybrid electric vehicles. Detecting and speciating emissions from lithium-ion batteries before and during a thermal runaway event provides an important understanding of the breakdown mechanisms. Our gas analyzers measure the concentration of multiple gases emitted during an event, in real time, enabling development of new and safer battery designs.

Cabin air integrity testing

Aerodynamic car designs positively impact fuel economy. Seal leaks in the car cabin disrupt the air flow around the car resulting in drag and decreased gas mileage. Newer vehicles are constructed to keep air sealed inside the vehicle rather than let it escape or enter. Our differential manometers are used to test vehicle cabin leakage, providing vehicle manufacturers insight into cabin air integrity.

ELECTRONIC SOLUTIONS – CREATING CONNECTIONS

Connector solutions

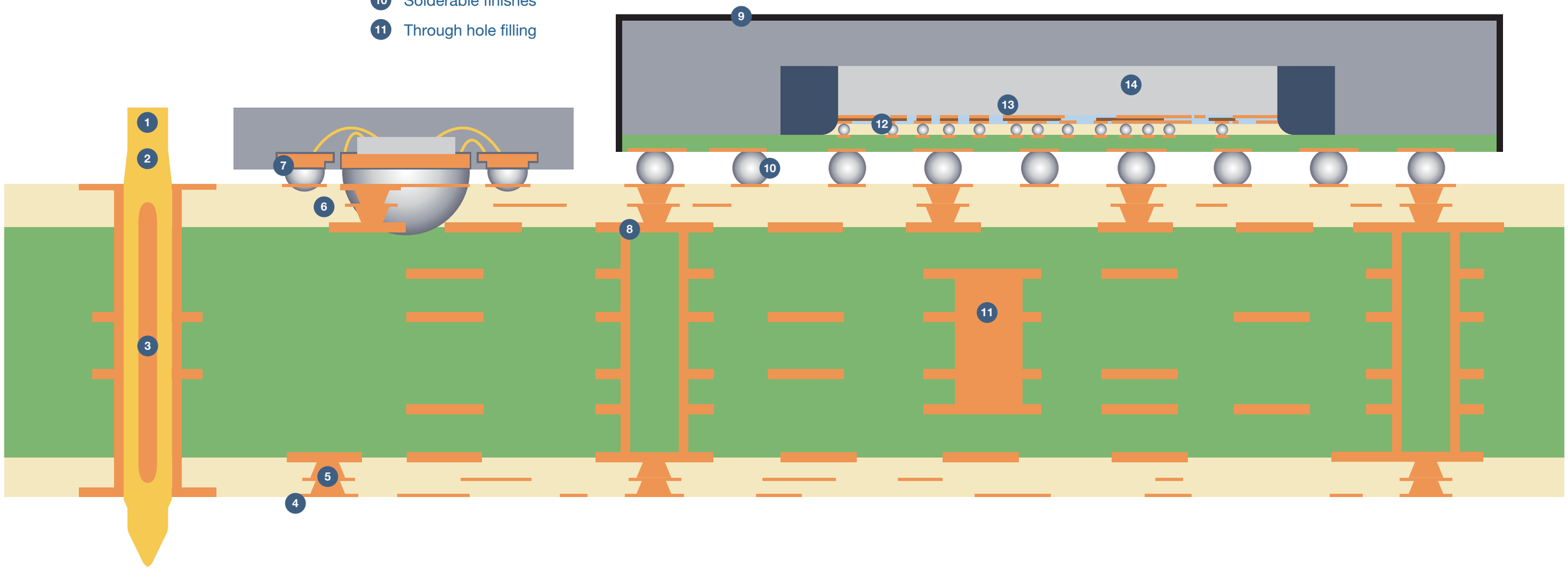
1. Connector
2. Press-fit contact
3. Flexible press-fit zone

Circuitry solutions

4. Full build copper plating
5. Copper via plating
6. Surface processing
7. QFN with wettable flanks
8. Through hole metallization
9. Electromagnetic shielding
10. Solderable finishes
11. Through hole filling

Semiconductor solutions

12. Solder bonding/wire bonding
13. Redistribution layers/pillars
14. Die interconnects



TECHNOLOGY CHALLENGES – KEY AREAS OF DEVELOPMENT

High Density Interconnect (HDI)

Surface processing

Surface treatment to ensure excellent adhesion for inner and outer layer PCB build-up is essential. Recent developments in the automotive industry require surface treatments that are not only suitable for high frequency applications, but also high voltage operation. MKS' high-end inner layer bonding and surface treatment products ensure optimal adhesion, great signal integrity, and thermal reliability under any condition.

QFN with wettable flanks

To assure that cars meet today's demand for safety and high reliability, false-free QFN solutions are needed. MKS offers state-of-the-art solutions for the production of quad flat no lead (QFN), such as thick immersion tin processes which produce three-dimensional solder joints, thereby assuring best reliability and yield. They are applicable for vertical as well as horizontal and barrel plating modes.

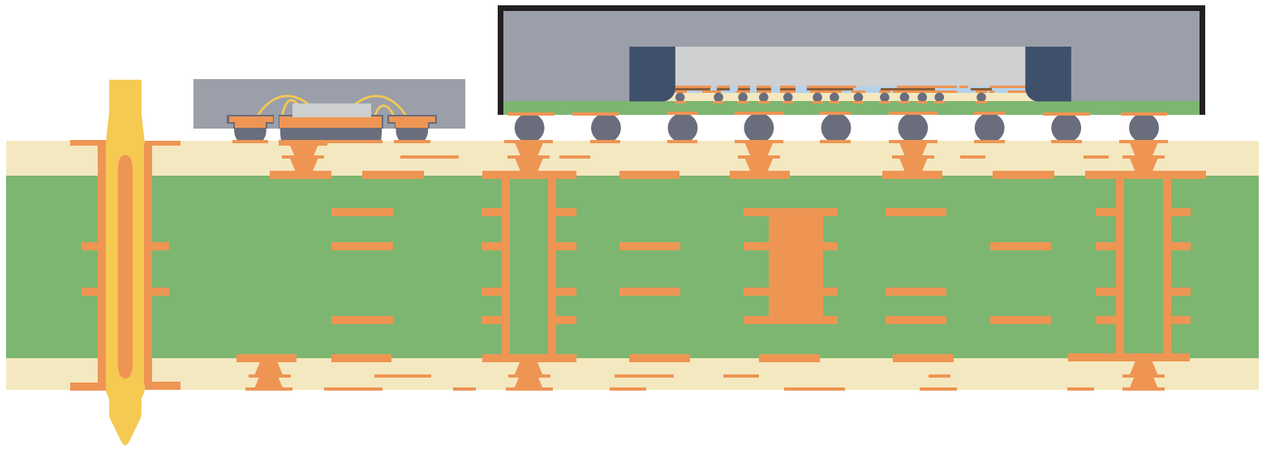
Electromagnetic shielding

Electromagnetic interference between different electronic components needs to be prevented by shielding. MKS offers a set of solutions which provide a stable composition of NiFe alloys, that are key to ensure shielding properties and an even distribution of NiFe.

Solder bonding

MKS has solutions for the different kinds of solder bonding technologies. For solder applications, we offer processes to deposit pure Sn and SnAg solder bumps, which fulfill the high reliability requirements of next generation advanced packaging applications. High CoP uniformities, long bath lifetimes, and high-speed plating are key, while simultaneously ensuring highest purity and void-free results.

For copper pillars, our solutions enable the deposition of highly pure and uniform Cu pillars at high deposition speed. They also meet new technological requirements such as mega pillar (tall pillar) plating with precise control over pillar shape (flat, concave, or convex), as well as plating of pillars of different dimensions in the same die.



Through hole metallization

The increasing concern of the industry over stacked BMV (blind micro via) reliability has led MKS to investigate into nano voids. The result is a series of products which assure nano void-free interfaces between the target pad and the electroless copper itself. Ideal for high-tech applications, these products ensure good throwing power and excellent coverage in even the most challenging of via geometries.

Wire bonding

For pad metallization, process solutions are needed which ensure high reliability. MKS solutions allow pad metallization with Ni/Pd and Ni/Pd/Au for an excellent contact and bond properties of wire to chip bonding. Our purest Pd solutions allow high reliability and stress-reduced deposits with an excellent process stability, while withstanding even high temperature budgets of up to 450 °C during chip processing.

Copper via plating

With the increasing requirements of high reliability industries such as automotive. MKS has developed a set of BMV and through-hole filling processes which are ideally suited for conformal copper plating and the needs of IC substrate manufacturing. All assure high productivity, excellent filling performance and crystal structures, and are ideal for vertical and horizontal equipment.

Solderable finishes

Immersion tin and OSP are the predominant surface finishes used for automotive electronics and need to meet critical application demands. MKS offers a market leading immersion tin which provides excellent solder joint reliability combined with outstanding corrosion resistance. Our Atotech OSP solutions offer a solderable environmentally friendly finish for fabricators and a stable organic coating even with more than five reflow cycles. They are suitable for SIT applications and work best in combination with Atotech ENIG processes.

Redistribution layers

The industry's need for faster and better performance requires the newest materials and processes. MKS solutions enable higher throughput, exceptional reliability performance, and optimal yield. Our Cu processes allow the deposition of highly pure and uniform Cu for RDL and via applications and hence significantly increase the reliability of the Cu structures. The high purity chemistries significantly reduce the level of additive incorporation and minimize the risk of microvoid formations.

Die interconnects

For die interconnects, damascene copper solutions are needed, which allow void-free and reliable fill through. MKS provides solutions which assure optimum fill performance at tailorable and highest Cu purity. They provide protection of the increasingly thinner seed layers and are designed for use on all mainstream ECD Cu platforms. These cost-effective solutions can be highly tailored to maximize yield and performance across a wide range of applications.

WHY MKS?

CRITICAL TECHNOLOGIES

World-class technology and development capabilities for leading-edge processes

PROVEN PARTNER

Recognized leader delivering innovative, reliable solutions for our customers' most complex problems

OPERATIONAL EXCELLENCE

Consistent execution across all aspects of our business

COMPREHENSIVE PORTFOLIO

Extensive offering of products and services for the markets we serve

MKS Instruments
www.mks.com

MKS INSTRUMENTS, INC. enables technologies that transform our world. We deliver foundational technology solutions to leading edge semiconductor manufacturing, electronics and packaging, and specialty industrial applications. We apply our broad science and engineering capabilities to create instruments, subsystems, systems, process control solutions and specialty chemicals technology that improve process performance, optimize productivity and enable unique innovations for many of the world's leading technology and industrial companies. Our solutions are critical to addressing the challenges of miniaturization and complexity in advanced device manufacturing by enabling increased power, speed, feature enhancement, and optimized connectivity. Our solutions are also critical to addressing ever-increasing performance requirements across a wide array of specialty industrial applications.

Additional information can be found at **www.mks.com**