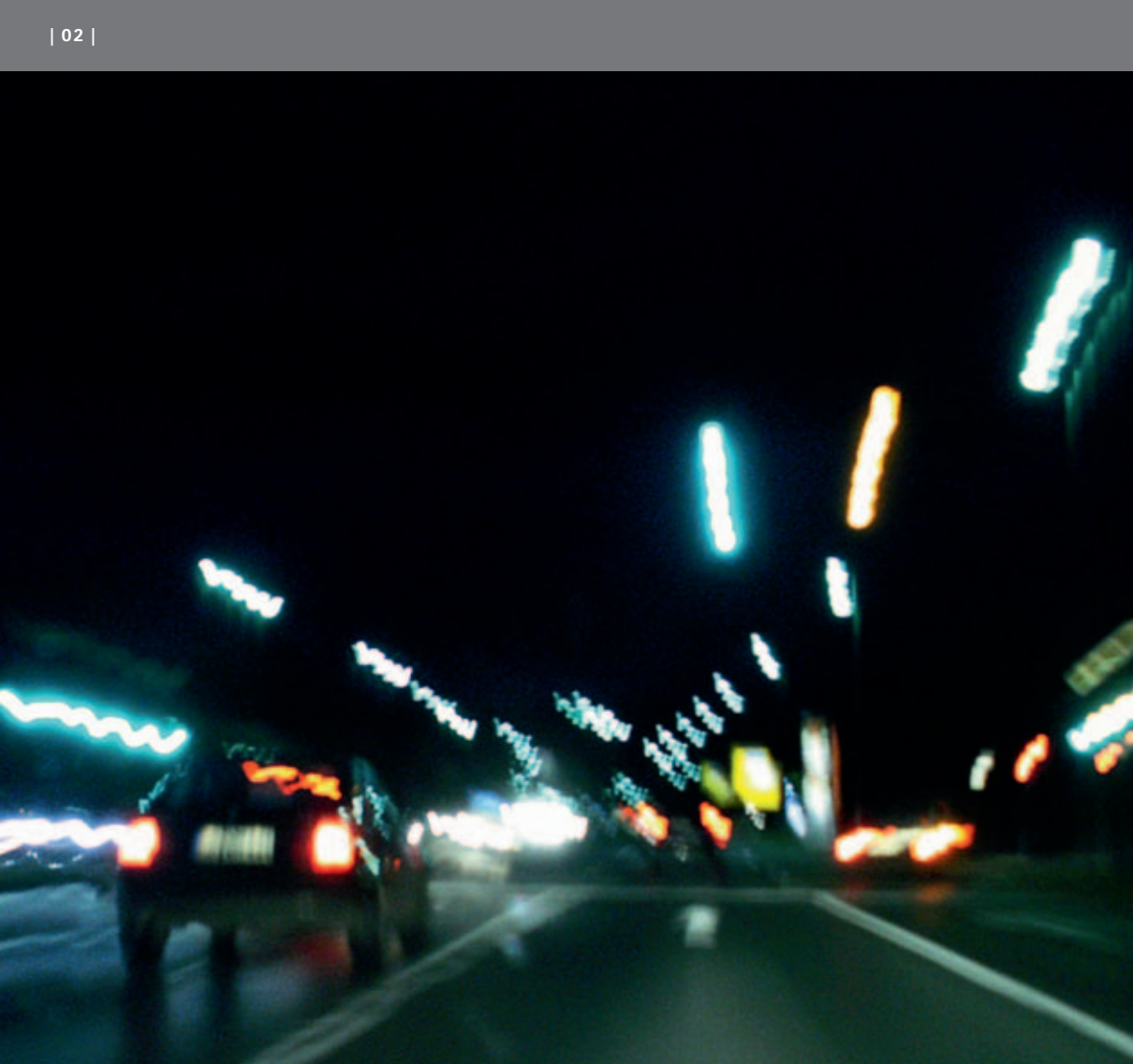


***Pole Position for Safe and
Enjoyable Driving***
High Tech Materials for the Car

Materials | Development | Solutions





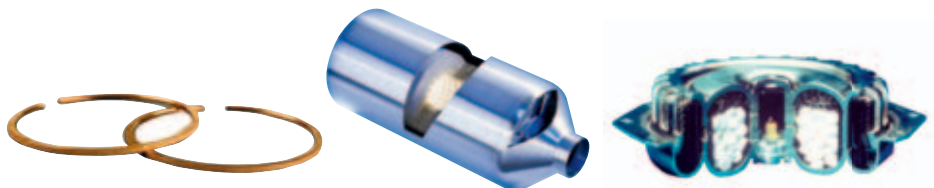
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Economical, Comfortable, Safe: Solutions for Modern Mobility

The car is a shining symbol of modern mobility. At the same time, it is one of our most important technology carriers. The proportion of supportive technology in the modern automobile has multiplied within the last few years, and an end is not yet in sight: greater engine efficiency and safety, more comfort, increased environmental protection and a longer service life. High tech materials from H.C. Starck, in numerous areas, make it possible that everything runs smoothly and that driving is fun: both inside and outside, in quantities large and small, visible and invisible.

Innovation Promotes Production

With pioneering and cost optimized material solutions, we contribute towards increasingly sophisticated cars and towards making their production more cost effective. In order to achieve these goals, we are already looking far to the future together with our customers and our customers' customers. Constant innovation – ranging from significant production improvements to completely new classes of materials – is a key factor for success in the competitive automotive industry and for its suppliers. With round about 3,200 experienced staff members at 13 production plants and strategically located sales offices in all high tech markets, H.C. Starck is truly a global player – always close to its customers and markets.



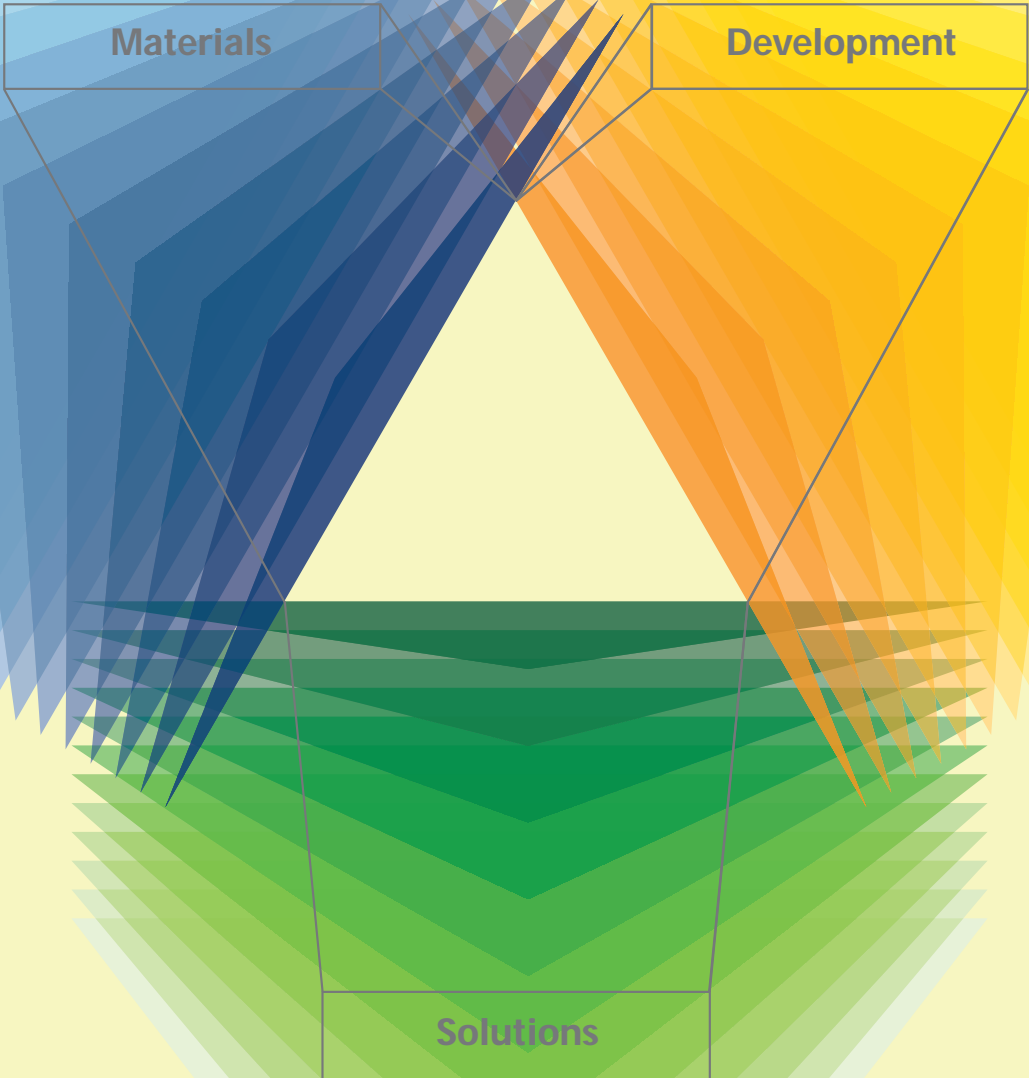
The Unique Integration at H.C. Starck

Three groups of materials represent our core products:

- The high melting refractory metals tungsten, molybdenum, tantalum, niobium, rhenium and their compounds
- Ceramic materials
- Electronic chemicals and functional materials:
conductive polymers

These materials make functionally an essential contribution in virtually all value added stages of the automotive industry. Future requirements and trends in automotive engineering make it increasingly necessary to combine the benefits of these three groups. H.C. Starck makes this possible thanks to innovative hybrid materials and technologies. Ranging from sophisticated production tools, to mechanical and electronic components for optimum operation to the very infrastructure, from innovative high tech material, customer focused development to individual solutions: Materials, Development, Solutions – this triangle describes the strength and breadth of our expertise.

- > **Materials: unique in breadth, depth and functionality**
Precise and reliable in terms of quality and quantity,
we offer a unique range of high quality intermediates.
- > **Development: know how for new markets; intensive**
research and development pave the way for new products,
applications and technologies.
- > **Solutions: essential contributions along the complete value**
chain; customized solutions for special requirements.



More Safety Means More Enjoyment at the Wheel

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No matter what achievements and inventions are called to mind, it is the car that embodies the desire to combine practicality with pleasure. In addition to comfort and enjoyment when on the road, materials from H.C. Starck above all ensure one thing: safety.



Electronics Are Everywhere

Air conditioning, electric seat adjustment, navigation system – are only some of the many electronic “assistants” in the car. To ensure that these components can function reliably, they require state of the art electronics with high performance capacitors and speedy computer chips.

With electronic engine control, and indeed also in safety systems, such as ABS and ESP, digital and analog technology must work reliably with a long service life under relatively tough conditions. This critical spectrum of requirements – increasing miniaturization, decreasing working voltages in digital technology, high working voltages in analog technology as well as up to extreme temperatures and corrosive influences – can only be achieved by tantalum and niobium high performance capacitors. Our unique powder technology, combined with the conductive polymer **CLEVIOS™**, will create new perspective for ever smaller and more efficient capacitors. H.C. Starck additionally supplies capacitor materials for other electronic appliances, such as radios or navigation systems.



Below: Tantalum and niobium high performance capacitors

Thin Layers for Speedy Chips

The production of ultra thin functional metal layers, e.g. by sputtering, is an important technology for the production of speedy microchips and modern displays. H.C. Starck supplies many specially developed material components on the basis of tantalum, tungsten, molybdenum and niobium as well as ceramic materials for the sputter targets employed in this process. Their advantages lie in the exactly controlled high purity, in special physical properties, such as high thermal and electric conductivity, high chemical and thermal stability and diffusion resistant effect, which are optimized in the thin layers by specifically set structures of the sputter targets.

“To Travel Hopefully Is a Better Thing Than to Arrive”



Comfort in the car is now virtually limitless. A further quantum leap are the modern navigation systems, which help us to arrive safer and stress free than ever before – sometimes with a “planned deviation” – at our destination. Ever smaller and more efficient capacitors, ever speedier chips and ever more safer and less stressed displays ensure that they function reliably – just like the many other electronic “assistants” in the car for which H.C. Starck has been providing important materials and innovations for decades.

Protected in Seconds

The ignition of airbags requires a material that reacts in split seconds in order to activate the generator for the airbag's filler gas. To this day, there is only one suitable substance: amorphous boron, from the market leader H.C. Starck, which supplies a large portion of the worldwide demand.



Left: Automatic anti dazzle rear view mirror
Right: Airbag safety system



Dazzle Free at a Safe Distance

Sensor controlled safety elements similarly use material from H.C. Starck: tungsten oxide reduces the annoying reflection effect in the electric anti dazzle rear view mirror thanks to its electrochromic properties. The same material might in the future also contribute to saving climate energy in other electrochromic glass forms, for example "smart windows". In addition, piezoceramic sensors help by means of ultrasound impulses to perceive and maintain the necessary distance from hazards.

See and Be Seen

Without light, sight is not possible: the lights on and in the car, and indeed also on roads and in tunnels, require high performance and long life halogen and discharge lamps for which H.C. Starck supplies the intermediates for high quality tungsten wires and electrodes. Self illuminating instruments and license plates, as well as design elements such as discreet door sill lights, have also become possible thanks to our conductive polymer **CLEVIOS™**.

Driving Right Under a Starry Sky – Possible Even Without a Convertible?



Cruising through the night in an open top car is really quite special. However, the weather unfortunately does not always cooperate. Modern high tech materials from H.C. Starck ensure that starry skies can also be enjoyed in a closed vehicle. Electro-luminescent lights using the conductive polymer *CLEVIOS™* are applied in this case as well as for a whole range of other useful and decorative applications in the car – from self illuminating instruments and license plates to countless design elements.

Quality Creates Trust

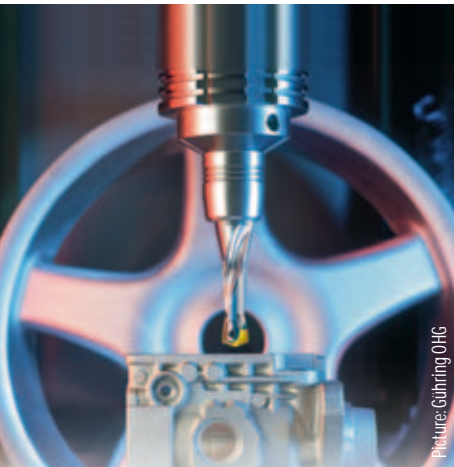
Buying a car represents a considerable investment. An important criterion when making a decision is value for money and a main consideration is for how long the engine will continue to function reliably.

Precision for Productivity

High tech cars require high tech production. In all instances where metal is machined – for the engine unit and cylinder head, the gears and drive systems, the brakes and instruments – high performance hardmetal tools for cutting and forming are used. In spite of all the electronics, the internal combustion engine and the mechanical parts, which put the horse power on the road,

remain the heart of every car. These require highly precise and productive production technologies and tools that can be achieved with the intermediates from H.C. Starck, such as especially high quality tungsten carbide powders.

Above: Hardmetal drill in use
Below: Diesel particulate filter



Pictures: Gühring OHG

Room for New Solutions

For diesel particulate filters H.C. Starck developed an option made of metal that withstands even the toughest conditions just like ceramics: this innovative alloy gives the industry more design leeway and provides solutions for better engine management – both ultimately also in the customer's interest!

Ideas for Efficiency

The less friction loss between piston and cylinder, the less fuel is required. This is why piston rings in internal combustion engines are coated with **AMPERIT**® alloys containing molybdenum and other high tech materials from H.C. Starck. As a result, minimum friction and a long engine life can be achieved with absolutely no loss of performance. In addition, the oil change intervals are markedly extended by molybdenum sulfide MoS_2 in the engine oil.



What Do David and Goliath Have in Common?



At a first glance, the smallest and largest vehicles seemingly have little in common. However, this does not hold true if we reflect for a moment. Almost always, quality and perfect operation are shared – and the high tech materials from H.C. Starck. They ensure in many areas, in both small cars and huge mining vehicles, a longer life and more safety, more cost efficiency and better environmental protection, more comfort and superior design. From robust and low emission engines to reliable onboard electronics, from air-bags, ABS and ESP to chassis with anti wear protection: H.C. Starck is present in all crucial parts.

Clean Is the Way Forward

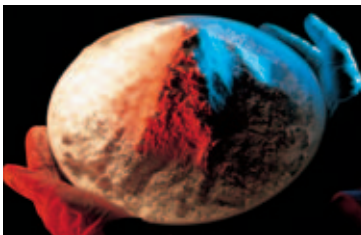
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Mobility and responsibility go hand in hand. In addition to active and passive safety, conservation of the environment is the key factor. Again in this case, material solutions from H.C. Starck can achieve these specific requirements.

More Performance – Less Fine Dust

High pressure diesel injection by means of electronically controlled piezo-actuators is one of the latest innovations in automotive engine construction. Compared to conventional technology with magnetic valves, piezoinjectors can be opened and closed much quicker and can be controlled more precisely. Engines with piezoinjectors are therefore considerably more efficient and quieter and furthermore afford more protection to the environment thanks to their lower exhaust values.

H.C. Starck supplies additives for the PZT ceramics currently used in these piezoinjectors and is intensively working on the next generation of piezoceramics, which will be lead free and thus even kinder to the environment than the current PZT ceramics.

Above: Injection valve
Below: Ceramic powder



- > **The new hybrid engines benefit from metal powders and machined parts on a molybdenum and copper basis for heat management and in performance electronics.**

What Will Provide the “Green Energy” of Tomorrow?



Already today, modern hybrid engines are a particularly environmentally friendly way to be mobile. H.C. Starck is also along for the ride: the heat management of the onboard electronics in the world's first hybrid series production car is markedly improved by our molybdenum and copper components. The fuel cell will enable even more efficient use of fossil fuels. Accordingly, H.C. Starck is pursuing a comprehensive solution: from the powder to the components to the unit supplying low emission power for the additional requirements of the air conditioning, temperature and lighting systems in cars and trucks – a solution also suited to boats and other mobile applications!

Mobile Future – a Question of Materials

The car will retain a central role for our mobility. The development of cleaner, safer and more comfortable vehicles necessitates integrated material expertise – right up to the design of completely new materials.



Highest Demands on Both Product and Production

Weight reduction to cut fuel consumption as well as the cutting of specific production costs are challenges faced every single day by engineers. Consequently, miniaturization and the use of cheaper production methods are top priorities. Fine, sinter active alloyed powders of the brand **AMPERSINT®MAP** from H.C. Starck make a valuable contribution and enable extremely cost effective forming processes.

In addition to soft magnets for smaller yet higher performance electric control units, important functional components in the engine and in related systems can also be produced from ultrafine and alloyed powder materials. And for innovative diesel particulate filters on a metal basis, high temperature resistant and corrosion resistant **AMPERSINT®MAP** alloys offer the right solution.

Further examples are the ever more efficient cuttings tools for production in the automotive sector, high performance capacitors and SAW filters (surface acoustic wave), e.g. for the engine control, as well as corrosion resistant and high temperature resistant iron base alloys for engines. Ever new possibilities for displays and design elements are afforded by the functional material **CLEVIOS™**.



At the same time, sensor and actuator engineering are becoming massively more important. Sensors in conjunction with distance radar units enable automatic acceleration and braking. The shape of future car roofs can also be aerodynamically influenced while driving by means of sensors and actuators. H.C. Starck supplies intermediates for improved and new sensor materials, such as piezoceramics.

Research and Development with Prestigious Partners

In all these endeavors, close cooperation with our customers and with renowned universities and research institutions worldwide is an indispensable integral component of our research and development – everything and everyone focused on one aim:

Empowering High Tech Materials!



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