

SOLUTIONS FOR AUTOMOTIVE EFFICIENCY

ThyssenKrupp

InCar[®]plus



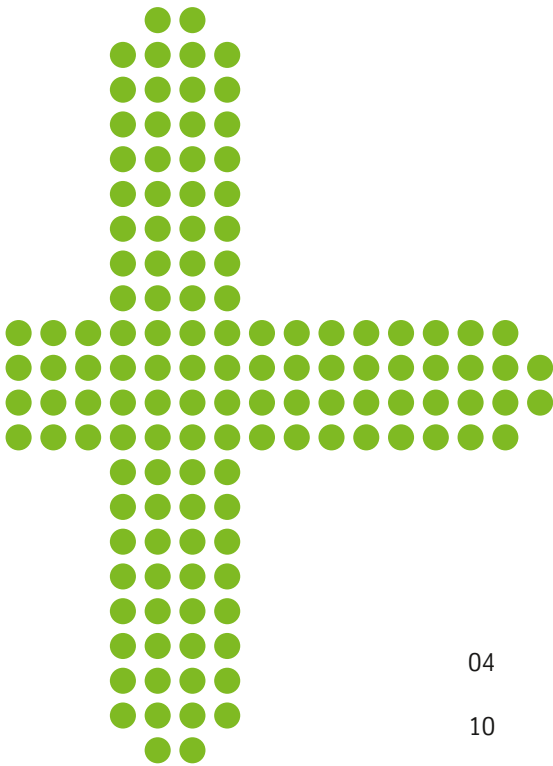
Developing the future.



ThyssenKrupp



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»InCar®plus solutions satisfy various customer needs according to vehicle-specific requirements.«

Dr. Karsten Kroos, Chairman of the Management Board of the Components Technology Business Area at ThyssenKrupp AG



»ThyssenKrupp leverages its combined expertise in material development, engineering and manufacturing.«

Dr. Heribert R. Fischer,
Member of the Executive Board of
ThyssenKrupp Steel Europe AG

Solutions for automotive efficiency

The ThyssenKrupp InCar®plus Project

ThyssenKrupp InCar®plus makes a substantial contribution to automotive efficiency. More than 40 innovative solutions set the standards for lightweight design, powertrain electrification, energy efficiency, as well as safety and comfort.

»InCar®plus solutions are up to
60 percent lighter and up to
10 percent less expensive than
our challenging benchmarks.«

Dr. Axel Grueneklee,
InCar®plus project manager





»Increasing efficiency by reducing fuel consumption is one of our key objectives.«

Claudius Rath, Powertrain project cluster manager

The automotive industry is experiencing a radical change. Urbanization is progressing at a fast pace, fuels are becoming more expensive and resources scarcer. At the same time, car ownership is increasing, especially in emerging countries, and freight transportation is also showing strong growth. The issue of climate protection is playing a key role. The targets for reducing greenhouse gases specified by governments around the world are ambitious. Further trends with high aspirations include connected and (semi-) autonomous driving solutions. It is essential to develop technologies that are both efficient and sustainable.

At the same time, globalization of the automotive industry continues to proceed. It is necessary to master the simultaneous production launch of new models worldwide. Modular model platforms are becoming increasingly important, but at the same time end customers are increasingly demanding customized products. Overall, competition is increasing, cost pressure is growing and development times are becoming ever shorter.

With ThyssenKrupp InCar®plus, we want to contribute to securing our customers' future success. In more than 30 projects and over

40 individual solutions, our engineers have developed new products in the areas of powertrain, chassis & steering and body. The focus is on environmentally friendly solutions related to energy efficiency, electric mobility and lightweight design. Whether it is weight, cost efficiency, sustainability or functionality: for at least one of these criteria, each of our InCar®plus innovations will exceed the current state of technology. With respect to weight, InCar®plus solutions show potential savings of up to 60 percent, with up to 10 percent cost reductions.

InCar®plus is currently the largest manufacturer-independent development project by an automotive supplier. It is impressive not only in its scope and diversity, but also in particular for the high level of maturity of the solutions. InCar®plus innovations are tested and validated with consideration to the entire value chain. This includes all the value chain steps of material processing, tool design, prototyping, and system assembly for large-scale production. The expected costs are also analyzed in the same way as the methods and tools needed to produce the InCar®plus innovations. Our teams have ensured that new solutions can be incorporated smoothly and rapidly into the production environment.

The cylinder head cover module with integrated camshafts is assembled in a hybrid housing comprising of polymer, aluminum and steel components. Weight savings: 15 percent.





»Innovative steering columns and damping systems are developed using new multi-material designs.«

Rainer Pudeg, Chassis & Steering project cluster manager

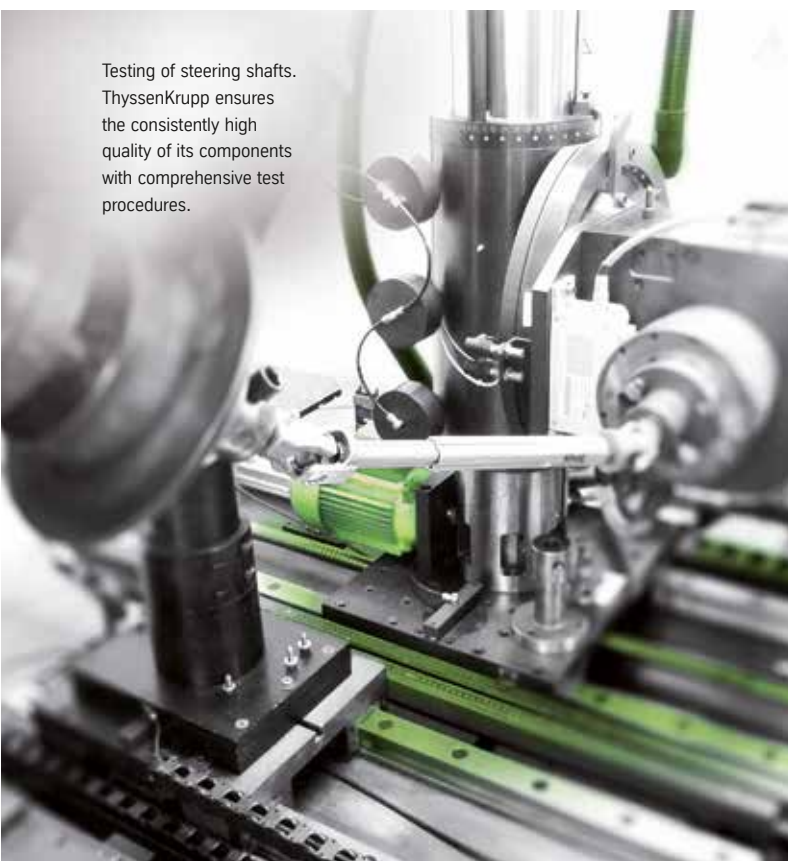
Life cycle assessment is also part of the project work for InCar®plus. We use integrated total life cycle analysis tools as a basis, which not only evaluate vehicle operation in the utilization phase, but also the environmental effects of production and recycling. With this information, the relevant environmental impact from the use of InCar®plus innovations is transparent from the start. Total vehicle life environmental performance is gaining increasing importance as a competitive factor in the automotive industry.

While current sustainability legislation mainly focuses on driving emissions, we look at the entire life cycle. Our life cycle assessments indicate the emissions for all phases of product life, from raw material extraction and processing, through material production and component manufacturing, including the application phase as well as any recycling influences. This information helps to make the correct selection from the increasing range of materials and processes. At the same time, it also demonstrates the ecological potential of improvements in areas such as powertrain, chassis & steering and body.

Fully validated solutions using an interdisciplinary approach

The entire automotive expertise of the ThyssenKrupp Group adds synergy to ThyssenKrupp InCar®plus. The Business Area Steel Europe is one of the world's technology leaders for the supply of flat carbon steel. The Business Area Components Technology, with its high-quality components, has a leading global market position in crankshafts, assembled camshafts, steering systems, damping systems, as well as springs and stabilizers. The Business Unit System Engineering is a system partner for all major components of the body and powertrain assembly process chains. This interdisciplinary set-up enables us to develop innovations with a high degree of maturity that are very closely matched to the needs of our customers: including required tooling technology, verified with specially made prototypes and a variety of tests.

Testing of steering shafts. ThyssenKrupp ensures the consistently high quality of its components with comprehensive test procedures.



Damping system fatigue test. In addition to solutions with innovative production processes, InCar®plus addresses damper tubes using multi-material design.





»The focus is on economical lightweight design, while meeting the increasing demands for crash safety.«

Markus Zoernack, Body project cluster manager

Powertrain project cluster

The conventional combustion engine will remain the dominant propulsion system in automobiles for the foreseeable future. ThyssenKrupp is setting new standards with further development of valve train solutions. Engineers have increased the efficiency of the internal combustion engine, resulting in significant reduction potential for fuel consumption and emissions. Developments and innovations in lightweight camshaft technology are a prime example. Alternative bearing concepts reduce internal engine friction losses. Also, by integrating new functions such as an oil separation system in the camshaft, InCar®plus creates added value for the customer. The integration of such features saves packaging space and reduces emissions.

Powertrain highlights also include a new hybrid cylinder head cover module with integrated camshafts. The hybrid housing utilizes and combines polymer, aluminum and steel components. The innovation results in a 15 percent weight reduction combined with acoustic improvements. By utilizing aluminum bearing blocks with cast-in support rings, friction losses can be reduced by approximately 10-15 watts and the required oil volume by 30-40 percent.

The powertrain sub-project also looks at innovative solutions for all aspects of electric drives. The goal is increased efficiency that results in better utilization of battery capacity. High-strength electrical steels with improved magnetic properties and increased mechanical strength allow higher rotational speeds. Hollow rotor shafts save 16 percent in weight and can provide additional package space inside the shaft for feeding oil or active rotor cooling.

Chassis & Steering project cluster

Electric power steering systems require much less energy than hydraulic solutions. At the same time, they make an important contribution to safety and enhance comfort. This technology change is a crucial prerequisite for modern driver assistance technologies such as automatic parking or lane keeping systems. Innovations from the Chassis & Steering sub-project are contributing to developing this technology for new vehicle classes and ensure even greater efficiency. In the project, we have worked on trend-setting technologies, such as steer-by-wire, and laid the foundation for the steering system of the future, based on a real test vehicle.

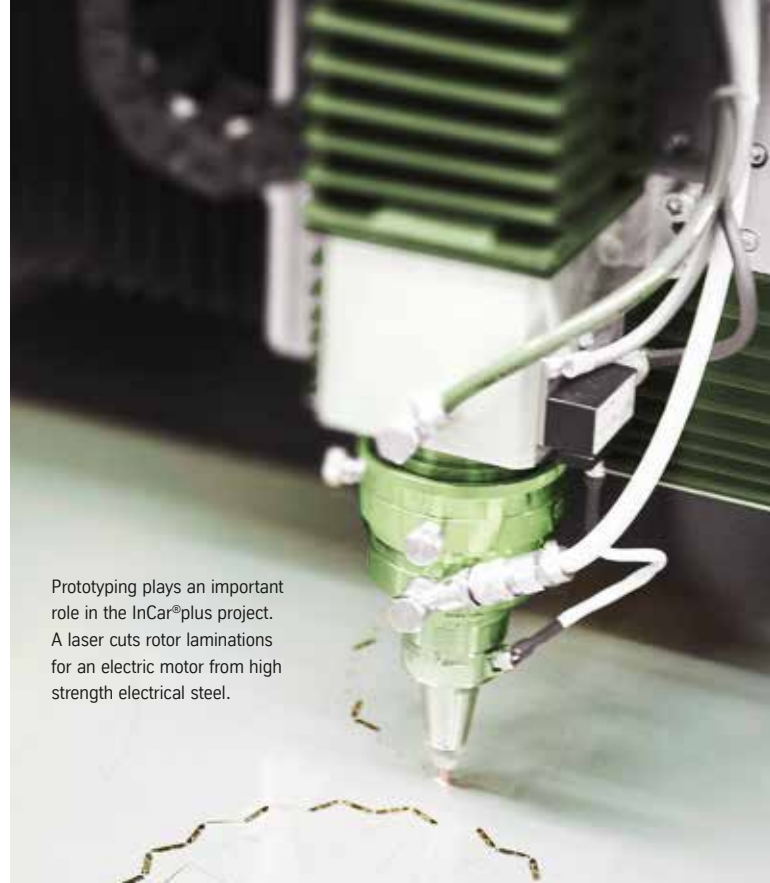
A further development focus has been on the multi-material design of damper tubes and steering components. For example, ThyssenKrupp has combined carbon fiber reinforced plastics or aluminum with established materials and made individual components up to 60 percent lighter. In addition to solutions for weight optimization, the team has also investigated cost reduction and additional system functions. Therefore, all customer and vehicle-specific requirements can be individually met, while applying cost-effective manufacturing processes for the economical mass production of the InCar®plus technologies. This was a essential part of the development agenda.



Roller hemming a LITECOR® outer skin. This technology has been tested under production conditions with short cycle times and enables a high-quality hem.



Wheel disk hot forming. With a prototype experimental tool, a wheel disk can be produced with greater design flexibility and high strength for lower weight.



Prototyping plays an important role in the InCar®plus project. A laser cuts rotor laminations for an electric motor from high strength electrical steel.

Body project cluster

Lightweight design is the main focus of the Body project cluster. New steel grades, semi-finished products, composite materials, magnesium and carbon fiber reinforced plastics make significant contributions. Materials-oriented, innovative designs leverage the potential of our products. We have developed new manufacturing and joining technologies on the basis of both our engineering and our materials expertise.

Hot forming plays a key role as one of the most important technologies for the economical lightweight design of safety components. This applies to both the development of new hot forming steel grades and refining the manufacturing technology itself. These advancements are implemented in components, such as B-pillars.

The InCar®plus engineers also address the body-related areas of seat structures and wheels. These are components that add significantly to the weight of the vehicle, and automotive manufacturers and customers have high demands in terms of comfort, functionality and design. Modern steel wheels have advantages over conventional cast aluminum wheels, not only in their significantly lower costs, but also because they weigh a lot less. As rotating masses, steel wheels benefit substantially from lightweight design. With regards to ecological evaluation criteria, substituting the steel wheel with supposedly more favorable cast aluminum solutions is counterproductive.

Over 20 percent weight reduction for the hood with attractive lightweight costs and consistently high performance can be achieved through the use of modern steel technologies and new design concepts. This lightweight potential can be leveraged by the use of modern sandwich products for the outer panel, combined with an optimized inner structure. LITECOR®, a composite of steel and plastic, is such an innovative sandwich product.

The InCar®plus solutions are an impressive demonstration of how the use of steel can achieve significant weight reductions, while being cost-effective.

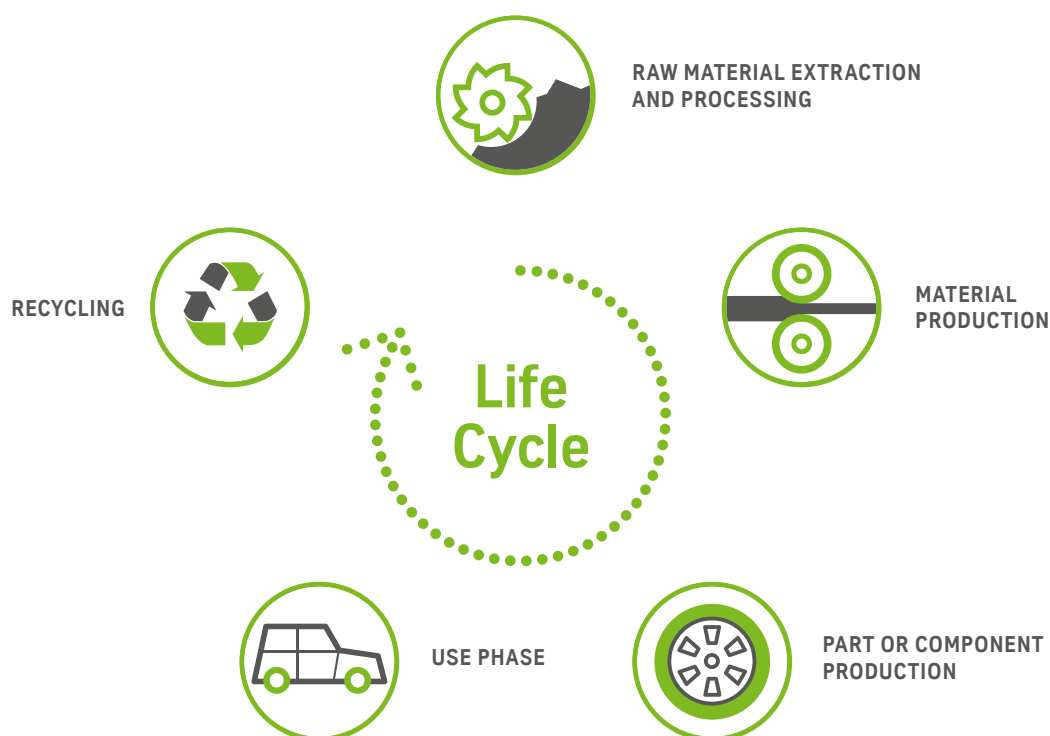


SUSTAINABILITY



Sustainability as an innovation driver The life cycle assessment

InCar®plus solutions help achieve a significant contribution to reducing CO₂ emissions during the use phase and also pursue an integrated approach that considers the entire life cycle of the vehicle.



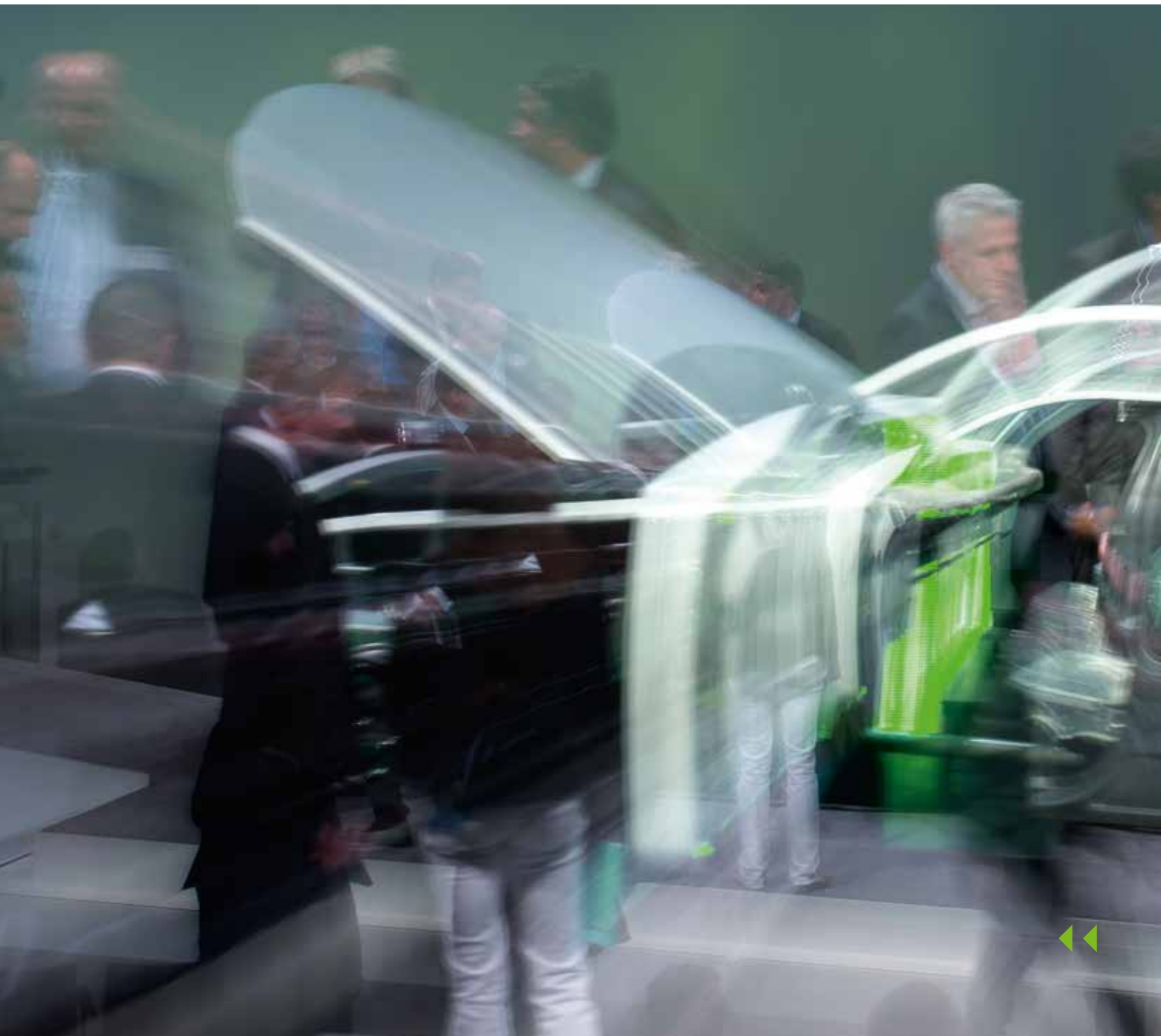
ThyssenKrupp sees sustainability as an innovation driver. Therefore, with InCar®plus, we have also put special emphasis on environmentally friendly, recyclable materials and vehicle components. The life cycle assessments for InCar®plus solutions show the emissions for all phases of the product life, from raw material extraction and processing, through material production and component manufacturing, to the use phase and recycling. They show improvements in almost all categories over the entire life cycle. From an integrated perspective, our life cycle assessments

consider the InCar®plus solutions not only in terms of possible greenhouse effects, but also cover other environmental indicators such as summer smog, over-fertilization and acidification. In addition, ThyssenKrupp has analyzed and evaluated resource and primary energy efficiency. Not all products with a good carbon footprint are necessarily environmentally sound in other categories. For example, they may reduce greenhouse effects, but nevertheless increase acidification potential. The InCar®plus level of responsibility for the environment reaches far beyond what is required by law.

ThyssenKrupp InCar®plus

Solutions for automotive efficiency

ThyssenKrupp InCar®plus makes a strong contribution to automotive efficiency, particularly with regard to fuel consumption, lightweight design, economical manufacturing and the integration of additional functions into existing components.





LIGHTWEIGHT



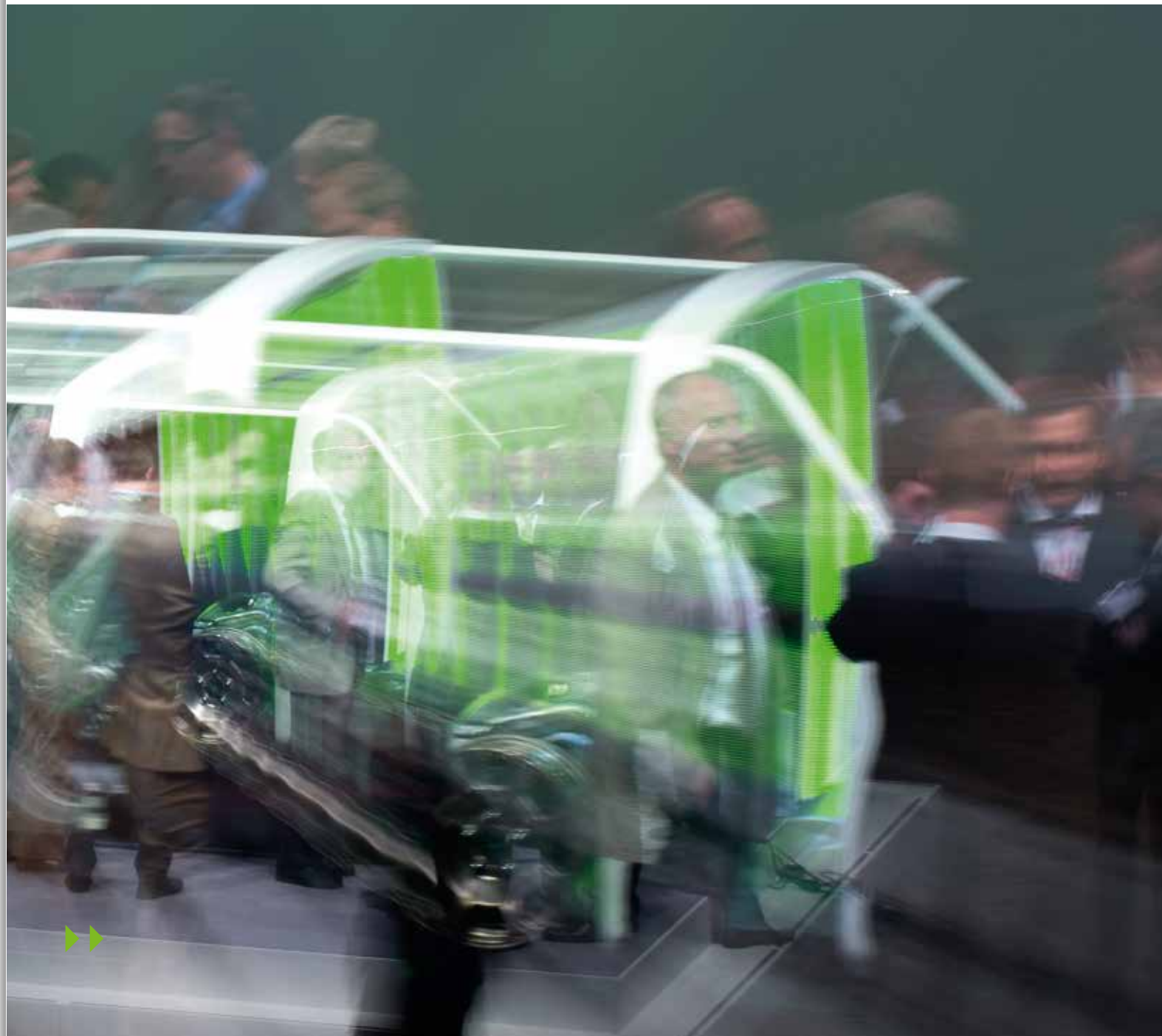
COST-COMPETITIVE



GREEN



HIGH-PERFORMING



ThyssenKrupp InCar®plus

Innovations in three product areas

InCar®plus is leveraging ThyssenKrupp's combined expertise in materials development, engineering, and the manufacture of high-quality components, modules and systems. This creates unique synergies that enable greater efficiency in powertrain, chassis & steering as well as body.

Powertrain

Increasing efficiency by reducing fuel consumption is a key objective of ThyssenKrupp InCar®plus. Because the conventional internal combustion engine will remain the dominant propulsion system for the foreseeable future, this is a focal point of the powertrain project cluster. Through the combination of advanced lightweight design and intelligent function integration, InCar®plus shows impressive solutions for better engines both today and tomorrow. Moreover, the project takes into account the increasing importance of electrical drive systems and solutions to increase their operating efficiency.

Chassis & Steering

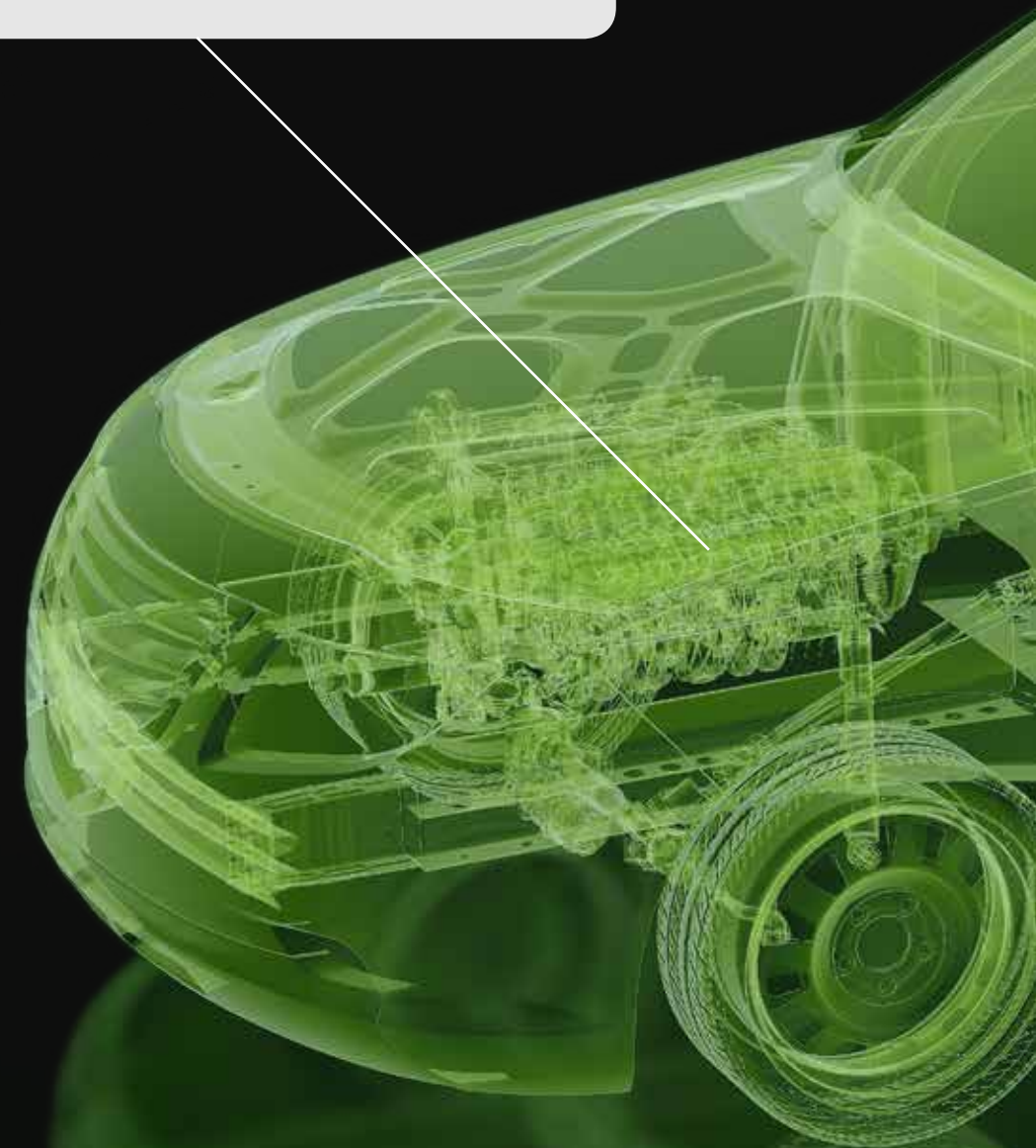
ThyssenKrupp InCar®plus is contributing to the technological shift towards electric power steering systems and developing the next generation for even greater safety and comfort. In the case of steering columns and damper tubes, innovative products are implemented using a multi-material design approach. The individual solutions address various customer needs, depending on vehicle-specific requirements. The priority is therefore either on weight optimization, cost reduction or additional functions within the systems.

Body

Economical lightweight design and increasing demands in respect of crash safety are the focus of modern car body developments. ThyssenKrupp is developing new materials, building tools and producing prototypes which are subjected to extensive testing – all from a single source. The advantage for customers: Innovative materials and production technologies can be implemented quickly in series production. The portfolio in the area of body includes not only structural and bolt-on parts, but also seat components and wheels.

Combustion engine solutions

- Systematic further development of camshafts and valve train modules
- Alternative bearing concepts for reduced internal engine friction losses
- Integration of oil separation systems into the camshaft or module



Body – structural and mounted parts

- • Use of new steel grades for cold and hot forming
- • Innovative composite materials
- • Further technological development of hot forming
- • Lightweight tubular design
- • Material-specific manufacturing processes for mass production

Body – wheels and seats

- • Lightweight steel design for seat structures
- • Cost-effective and innovative steel wheels
- • Hybrid wheel made from CFRP and steel

Electric drive

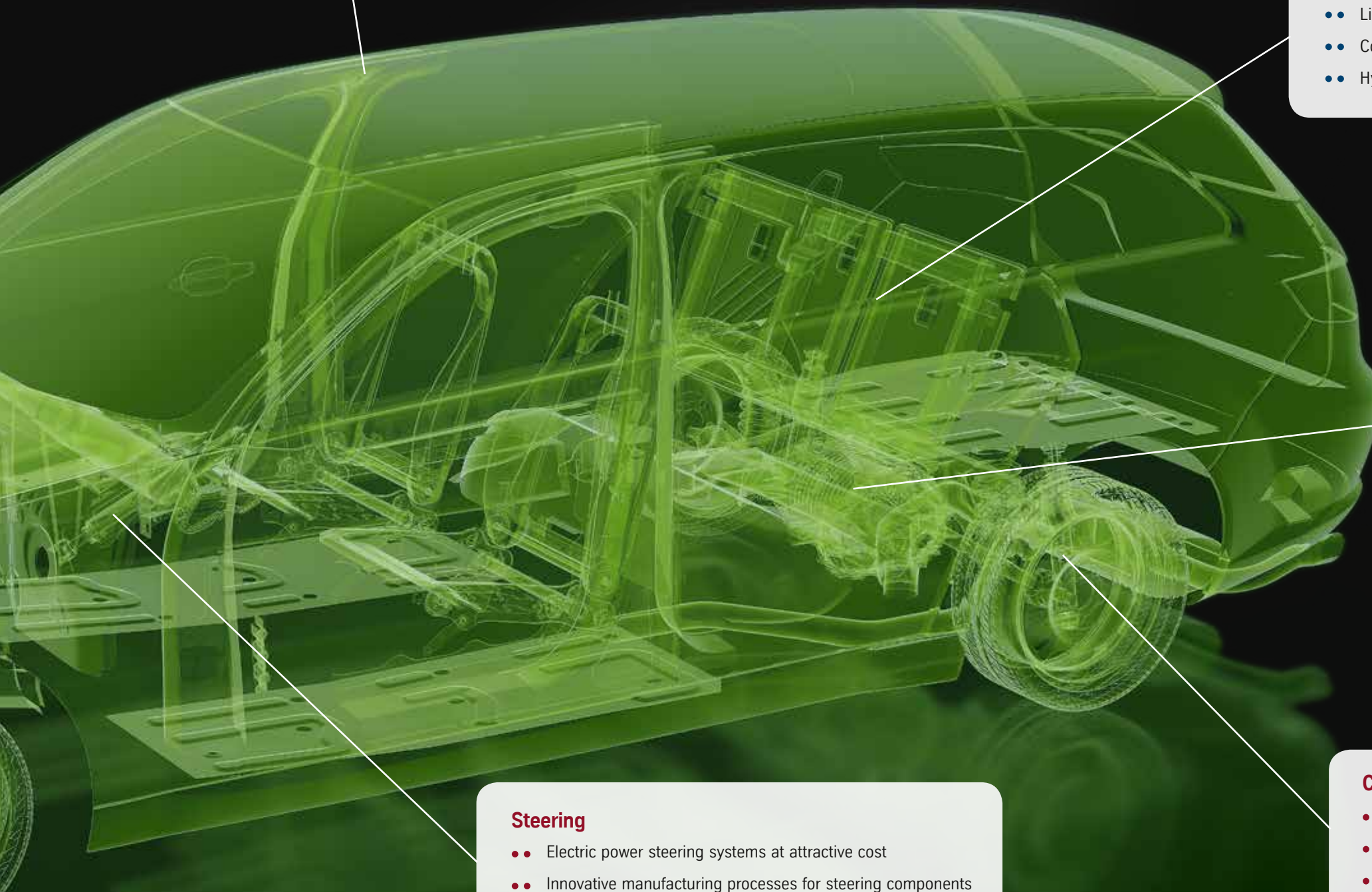
- • High-strength electrical steel grades
- • Assembled lightweight rotors
- • Use of assembled gear shafts for electric drives

Steering

- • Electric power steering systems at attractive cost
- • Innovative manufacturing processes for steering components
- • Multi-material design for steering components
- • Development platform for steer-by-wire systems

Chassis

- • Innovative manufacturing processes for chassis parts
- • Multi-material design for chassis components
- • Fast variable damping system for increased safety



All powertrain solutions

Efficiency of internal combustion engines and electric motors



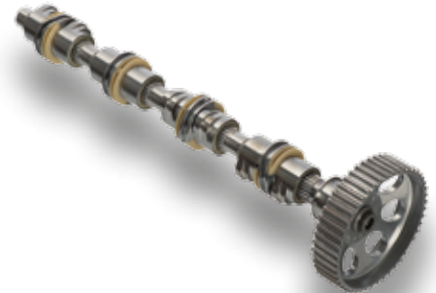
Camshaft friction reduction

The valve train accounts for around 15 percent of friction losses in the engine. ThyssenKrupp systematically analyzes new surface modification and coating processes for camlobes and camshaft bearings, aiming at significantly reducing friction. Specially developed test beds will allow an objective, engine-independent comparison in the future.



Camshaft integrated oil separation system

ThyssenKrupp has successfully integrated the oil separation system for blow-by gas into a camshaft, as part of the crankcase ventilation system. The technology known as the Presta Oil Separation System (POSS®) surpasses the filtration efficiency of most of today's passive systems, while occupying only a small amount of packaging space.



Hybrid shifttable cam elements improve valve lift switching systems

ThyssenKrupp has developed an adjustable cam element for variable valve lift systems which, through its hybrid design (steel/plastic), is up to 30 percent lighter than a reference component made from steel. This weight advantage allows an increase in the rotational speed limit for camlobe switching. Such systems result in potential savings in fuel consumption of up to 5 percent.



Europäische Union



Europäischer Fonds für regionale Entwicklung



Hybrid design optimizes camshaft modules

Cylinder head cover modules with integrated, assembled camshafts achieve significant weight, friction and cost advantages. Using polymer, aluminum and steel components, ThyssenKrupp shows how a hybrid housing can achieve a further 15 percent weight advantage. Innovative camshaft bearings reduce friction losses by 10-15 watt, and reduce oil demand in the friction bearings by 30-40 percent.



Heat-resistant, density-reduced steels for exhaust systems

Heat-resistant, density-reduced steels have favorable properties for exhaust systems due to their chemical composition. Although their material development is not yet complete, a favorable property profile is nevertheless emerging: high strength in the relevant temperature range, high corrosion resistance, low thermal conductivity and low density.



High-strength, non grain oriented electrical steel

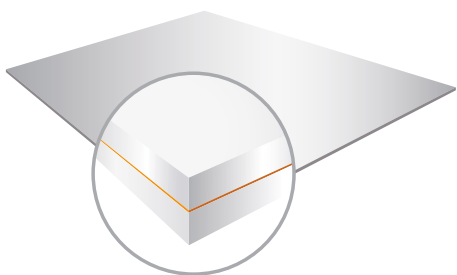
ThyssenKrupp has developed new types of electrical steel which have helped significantly increase the torque of an electric traction motor compared to the best standardized grade M 235-35 A. Furthermore, the new grades feature magnetic guarantees for increased frequencies of, for example, 400 Hz with a simultaneously guaranteed yield strength of more than 420 MPa.



Europäische Union



Europäischer Fonds für regionale Entwicklung



BONDAL® E improves the acoustics of electric motors

The three-layer composite material BONDAL®E, which is still under development, has the potential to reduce stator noise emissions by up to 10 dB(A). The high structure-borne sound insulation level is achieved with a very thin interlayer of plastic, so that the stacking factor remains virtually unchanged and the power density of the electric motor is maintained.



Packaging space and cost-optimized shafts for electric drives

In the eTDC (electromobile ThyssenKrupp Drivetrain Components) project, an intelligent drive structure with lightweight components solves the trade-off between efficiency and cost/packaging space for electric motors. The assembled integrated rotor/transmission shaft enables the combination of different steel grades, while at the same time being highly cost-effective.



Lightweight rotor with integrated cooling system

As part of InCar®plus, ThyssenKrupp is developing a hollow cylindrical rotor architecture: the multi-part, modular design of the rotor saves up to 16 percent in weight and generates, in the chosen reference design, freely usable packaging space of more than 800 cm³ inside the rotor. Active rotor cooling can, for example, be integrated for a further improvement in efficiency.

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and Research



Lightweight, electrified steel rear axle

Steel is also vital for electrified vehicles due to its many positive properties. A concept study that uses the example of an electrified rear axle as part of a hybrid drive demonstrates lightweight design potential using steel. For this purpose, the electric drive unit is integrated into a rear axle subframe whose packaging space and weight have been optimized.



Plasma-modified bipolar plates for fuel cells

A preliminary study shows that fuel cell stacks with bipolar plates made of plasma surface-modified stainless steel have great technological potential. Compared to gold-coated bipolar plates, the new solution is about 60 percent more cost-effective. Compared with similarly expensive bipolar plates made from graphite composite materials, this achieves weight savings of around 5 percent and an approximately 25 percent reduction in required packaging space.

All chassis & steering solutions

Electric power steering systems and material mix



Saving weight and space with ThermoTecWire®

Vehicle suspension springs made from ThermoTecWire® are nearly 20 percent lighter than conventional suspension springs and thereby make an outstanding contribution to lightweight design in the suspension. In addition to advantages with respect to fuel consumption and emissions, this also results in package gains, since the spring made with the innovative wire is significantly shorter.



Function-optimized damper tubes

ThyssenKrupp has developed new damper tubes for individual package requirements, customized welded variants with an optimal cost and function level, as well as a special weight-optimized lightweight solution. This damper tube made from CFRP is up to 45 percent lighter than an aluminum damper tube. Stainless steel tubes provide increased corrosion resistance for single and twin-tube damping systems.



Integrated variable damping system

The new ThyssenKrupp integrated variable damping system has a stepless, fast-acting, pilot-controlled pressure relief valve. The wide spread of the damping force in the rebound and compression stages, as well as the high adjustment dynamics, solve the trade-off between ride comfort, handling safety and agility even better. A solenoid pilot valve precisely controls the pressure for the two independent main valves of the rebound and compression stages.



Economical lightweight steering columns with CFRP components

With CFRP components, a maximum weight reduction of up to 60 percent can be achieved for steering column components, and up to 25 percent for a complete steering column, while delivering performance equivalent to that of mass-produced steering columns. Automotive processes suitable for mass production include winding pultrusion for the column jacket and the Resin Transfer Molding process with tailored fiber pre-forms for brackets.



Hybrid steering shaft: 35 percent less weight

Up to 35 percent lighter than a reference steering shaft with lightweight design costs of less than €5/kg: that is the promise of a tube-in-tube lightweight solution with optimized aluminum yokes. Their modular design offers maximum flexibility. Using a high-performance polymer, the sliding connection withstands short-term temperatures of up to 200°C.



Lightweight, hollow steering rack

Compared with a machined steering rack, a sheet-metal version is about 25 percent, or 0.5 kg, lighter due to its hollow cross section, and is compatible with both constant and variable gears. If necessary, smaller motors can also be used in an electromechanical steering. Compared with conventional variable racks, production costs are on the same level.



Superimposing actuator: high performance at attractive costs

The newly developed gearbox as the "centerpiece" of the superimposing actuator significantly improves both the acoustic properties and the cost of the module. Plastic gear wheels offer a sufficiently high performance level at competitive cost. The system performance of the complex mechatronic system has been demonstrated by ThyssenKrupp.

Column EPS for compact and mid-size vehicles

As part of InCar®plus, ThyssenKrupp has developed a new Column EPS system in two variants for steering rack forces of 9 and 11 kN. Both the steering feel and the noise characteristics are significantly better in comparison with current Column EPS solutions. Moreover, it has proven to be more cost-effective and compact than Rack-and-Pinion EPS systems typically used in these vehicle segments.

Development platform for steer-by-wire systems

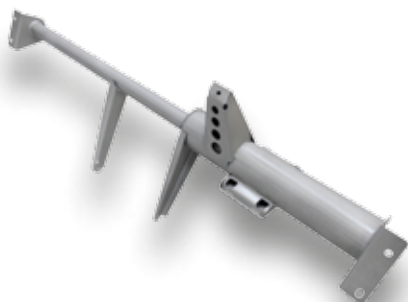
ThyssenKrupp has equipped a flexible experimental test vehicle with a steering gear and feedback actuator that allows both fail-safe and fault-tolerant steer-by-wire systems to be tested. This development environment enables complex requirements with respect to actuators, sensors, fault tolerance and controls to be defined and developed into production-oriented steer-by-wire systems.



A sports car is the basis of the development platform for steer-by-wire systems.

All body solutions

Economical lightweight design and crash safety



New lightweight design approach to cockpit beams

This magnesium cockpit beam is more than 3 kg lighter than conventional steel solutions, at lightweight costs of just over €5/kg. It consists of a double-tube system with additional components made of magnesium sheet and is joined by MAG welding. The performance characteristics of the cockpit beam have been virtually validated.



Optimized bumpers save up to 19 percent weight

A new bumper system with hot-formed steel crash beams from MBW® 1500 can be up to 19 percent lighter than the InCar®plus reference solution at comparable cost. This corresponds to the weight of aluminum solutions, at a considerably lower cost. New material and component ideas enable integration into existing vehicle structures and adaptation to common crash loads. In addition, modular and roll-formed crash beams have been developed that are up to 17 percent lighter.



Optimized manufacturing processes make longitudinal members lighter

The InCar®plus longitudinal member is an innovative steel multi-section profile made of a shell component and T³ profile. It can be manufactured with conventional production technologies and is up to 23 percent lighter and 10 percent more cost-effective. Thanks to its modular structure, it is adaptable to various vehicle segments and provides superior crash properties. Using an innovative combination of materials with a cost advantage of up to 8 percent, the weight advantage amounts to as much as 31 percent.



Slim A-pillar: better visibility, less weight

The new InCar®plus A-pillar offers numerous advantages: a significantly improved field of vision, a high level of passive crash safety and about 10 percent less weight. The reduction in material usage and new manufacturing technologies ensure very moderate lightweight costs of about €1.50/kg. The simple integration of the new A-pillar concept into a modular strategy offers possible cost advantages.



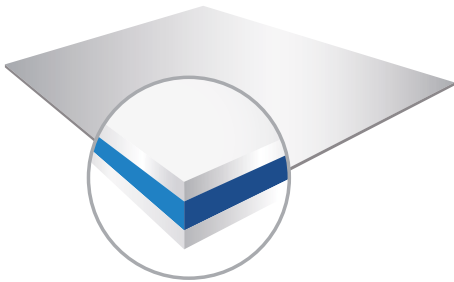
Greater safety through weight reduction in B-pillars

The hot-formed and roll-clad steel-composite material TriBond® 1400 allows for a weight reduction of 1.28 kg per vehicle compared to a tailored tempering B-pillar made of MBW® 1500. The lightweight design costs amount to less than €1.50/kg. Cold forming can also provide lighter and more cost-effective B-pillars. New materials, such as DP-K® 700Y980T, open up further potential for lightweight design and cost advantages.



Light, cost-effective steel seat structures

Seat structures are very important for lightweight design since they weigh about 40 to 60 kg per vehicle. Through the use of new steel grades, such as MHZ 500 or DP-K® 700Y980T, seat components can be made up to 15 percent lighter at no additional cost. Seat cushion pans made of LITECOR® can be as much as 37 percent lighter – with lightweight costs of less than €3/kg.



LITECOR® body components

For InCar®plus, ThyssenKrupp has designed and tested the feasibility not only for outer skin components, but also for structure-relevant internal parts made of LITECOR®. The 14 components made of LITECOR® feature the same performance as conventional components but are a total of 19 kg (about 20 percent) lighter.



Innovative hood concepts

Modern steel technologies and lightweight design concepts make hoods more than 20 percent lighter. The rigid and lightweight LITECOR® composite material realizes this potential without compromising performance and safety, while achieving low lightweight costs. A multi-material concept allows for weight advantages of up to 40 percent.



Lightweight outer skin solutions

Innovative steel products reduce the weight of outer skin panels such as doors by up to 33 percent without losses in oil canning behavior and dent resistance and at very attractive lightweight costs of slightly more than €2/kg. ThyssenKrupp has demonstrated the mass production feasibility of the steel-polymer composite LITECOR® using a front door as an example.



Steel wheels – light and stylish

ThyssenKrupp developed lightweight steel wheels that are up to 20 percent lighter than existing wheels and are therefore more lightweight, more cost efficient and more ecological than cast aluminum wheels. The steel design wheel features a modular design which combines attractive styling with high design flexibility. The highlight is a 20-inch hybrid wheel made of steel and carbon fiber reinforced plastic (CFRP).

The right product for every requirement

Advantages at a glance

InCar®plus solutions satisfy different customer needs depending on vehicle-specific requirements. The priority is either on weight optimization, cost reduction, sustainability and/or additional system functionality.

Powertrain

Project Title

Solution

Optimized combustion engine

Friction-optimized camshaft	
Oil separation system (POSS® Presta Oil Separation System)	
Hybrid shiftable cam element	
Hybrid cylinder head cover module	
Exhaust system	

Electric drive

High-strength electrical steel	
Acoustically optimized electric motor	
Assembled gear shaft (eTDC electromobile ThyssenKrupp Drivetrain Components)	
Assembled rotor	
Electrified rear axle	
Fuel cell	

Chassis & Steering

Chassis

Springs (ThermoTecSpring® made of ThermoTecWire®)	
Damper tubes	T ³ -damper tube
	Stainless steel damper tube
	Tailor-welded damper tube
	CFRP damper tube
Variable damping system	

Steering

CFRP steering column	
Hybrid steering shaft	
Hollow steering rack	
Superimposing actuator	
Column EPS	
Steer-by-wire	



Category	Sub-category	Item	Value	Color
Category 1	Sub-category 1.1	Item 1.1.1	10	Blue
		Item 1.1.2	20	Blue
		Item 1.1.3	30	Blue
		Item 1.1.4	40	Blue
		Item 1.1.5	50	Blue
	Sub-category 1.2	Item 1.2.1	60	Blue
		Item 1.2.2	70	Blue
		Item 1.2.3	80	Blue
		Item 1.2.4	90	Blue
		Item 1.2.5	100	Blue
Category 2	Sub-category 2.1	Item 2.1.1	10	Orange
		Item 2.1.2	20	Orange
		Item 2.1.3	30	Orange
		Item 2.1.4	40	Orange
		Item 2.1.5	50	Orange
	Sub-category 2.2	Item 2.2.1	60	Orange
		Item 2.2.2	70	Orange
		Item 2.2.3	80	Orange
		Item 2.2.4	90	Orange
		Item 2.2.5	100	Orange
Category 3	Sub-category 3.1	Item 3.1.1	10	Green
		Item 3.1.2	20	Green
		Item 3.1.3	30	Green
		Item 3.1.4	40	Green
		Item 3.1.5	50	Green
	Sub-category 3.2	Item 3.2.1	60	Green
		Item 3.2.2	70	Green
		Item 3.2.3	80	Green
		Item 3.2.4	90	Green
		Item 3.2.5	100	Green





The right product for every requirement

Advantages at a glance

Body

Project Title	Solution
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Cockpit beam	Magnesium
Bumper systems	Open crash beam
	Modular crash beam variants
	Roll-formed crash beam
Longitudinal member	Double section profile
A-pillar	Hot-formed profile
B-pillars	Cold forming
	Hot forming
Seat structures	Backrest side member
	Cushion side member
	Cushion pan
LITECOR® potential analysis	Concept analysis, full body
Hoods	LITECOR®
	Steel-magnesium hybrid
Door	LITECOR®
Wheels	Lightweight steel wheel
	Steel design wheel
	Steel-CFRP hybrid wheel

	 LIGHTWEIGHT	 COST-COMPETITIVE	 GREEN	 HIGH-PERFORMING
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General note
All statements as to the properties or uses of materials or products are for descriptive purposes only. Calculations and technical assessments relate exclusively to the reference structure or the stated reference products and will require renewed investigation or express confirmation in concrete cases of use of the respective material or product. Guarantees in respect of specific properties or uses are only valid if agreed in writing.

A close-up, low-key photograph of a car's instrument cluster. The background is dark, with several glowing green vertical bars (needles) visible. On the right side, a portion of a circular gauge with white tick marks is visible. The overall mood is mysterious and high-tech.

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