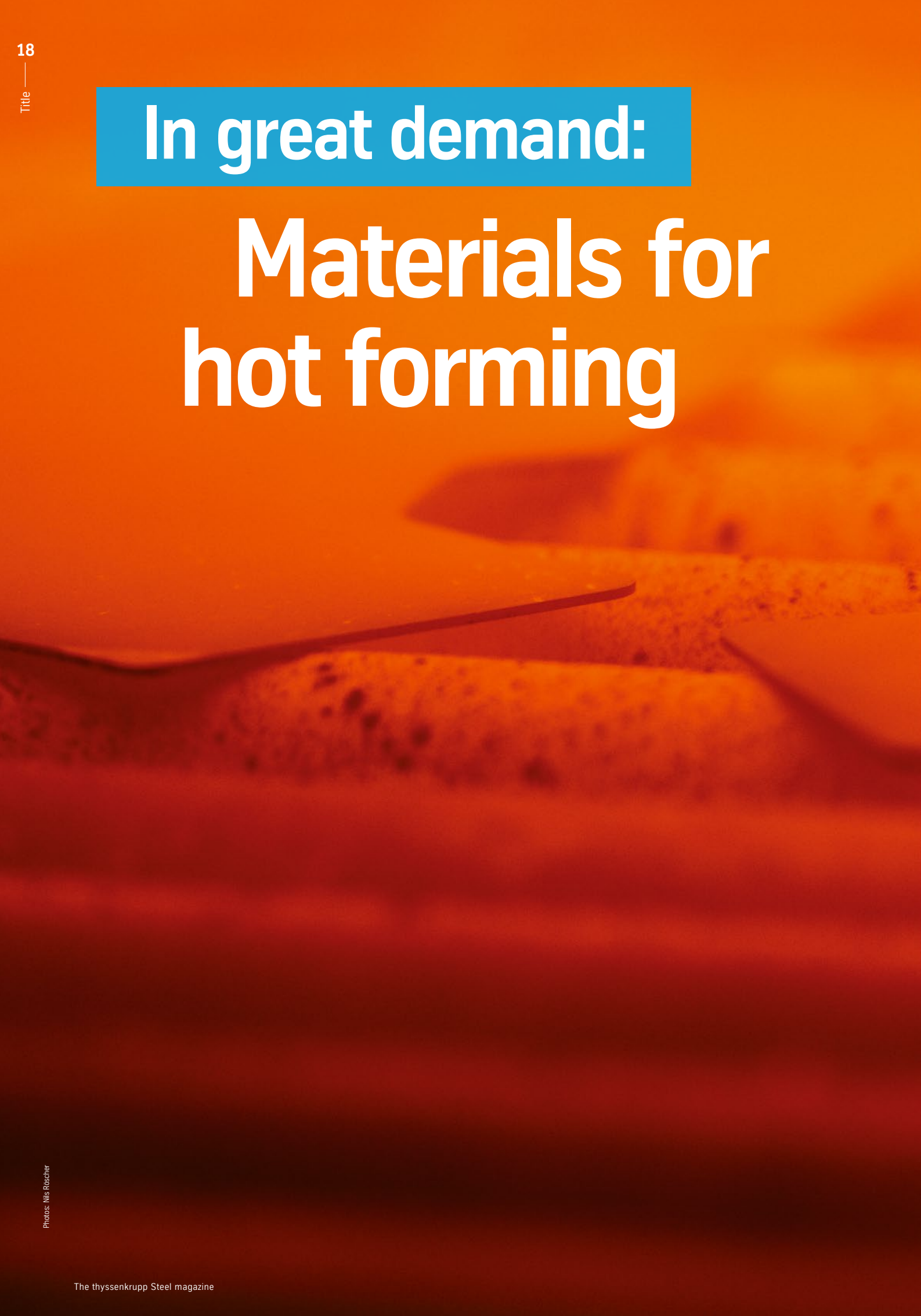
In great demand:

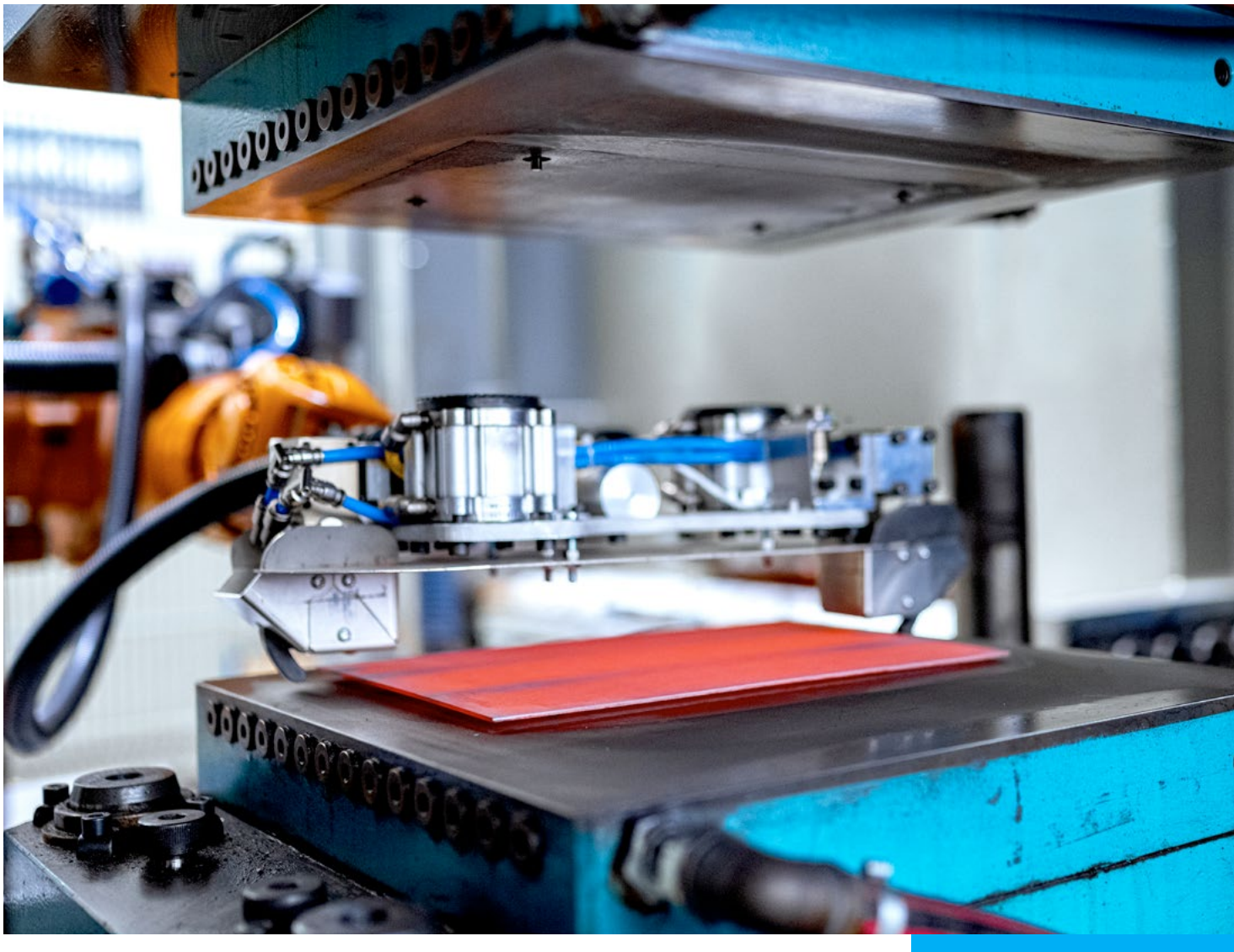
Materials for hot forming



Photos: Nils Röscher

Steel is unmatched when it comes to economical lightweight construction in the automotive industry. Hot forming has played a large part in this success. With innovative materials and comprehensive service packages, thyssenkrupp Steel is supporting its customers in applying this manufacturing process, which makes efficient use of materials.

Text Katja Marx



The first patents for hot forming with direct press hardening of steel were registered 50 years ago. The materials treated in this way achieved a high final strength, making them particularly popular in agriculture: expensive tools such as harrows, plows or spades were better protected against wear by using manganese-boron-alloyed steels.

The automotive industry only recognized the potential of the process later. After the hot-formed steels initially had proved themselves on simple components, innovative material and coating concepts expanded the possible areas of application in the bodywork. As a result, the first manufacturers began to produce more complex, safety-relevant components with hot-formed steels in the 2000s. Since then, growing demands in terms of safety and environmental compatibility of motor vehicles have reinforced this trend.

Between customer requirements and cost pressure

"More than ever before, the automotive industry needs materials that combine diverse, sometimes contradictory requirements," says Rüdiger Schorn, Product Manager Hot Forming at thyssenkrupp Steel. "For example, high crash performance with simultaneous weight reduction, and thus material savings. Or alternatively, an increased use of lightweight materials without significantly increasing costs."

The trend towards intelligent component integration – where several components are joined together before they reach the assembly line – is also boosting production efficiency on the part of original equipment manufacturers (OEMs). To ensure that the individual elements of the vehicle do not lose any of their functionality, it is necessary to address the question of how different requirements can be combined in a single, complex component.

Lightweight and safe at the same time

Manganese-boron hot-forming steels provide a comprehensive answer to these requirements. The material is typically heated to between 880 and 950 °C, formed in a heated state, and then rapidly cooled in a targeted manner. The advantage: the method can be used to produce geometrically complex components with high dimensional accuracy, which have a high final strength and thus a pronounced lightweight construction potential due to the temperature control in the process. At the same time, the high-strength steel grades are particularly suitable for safety-relevant components in vehicles.

Photos: Nils Roscher

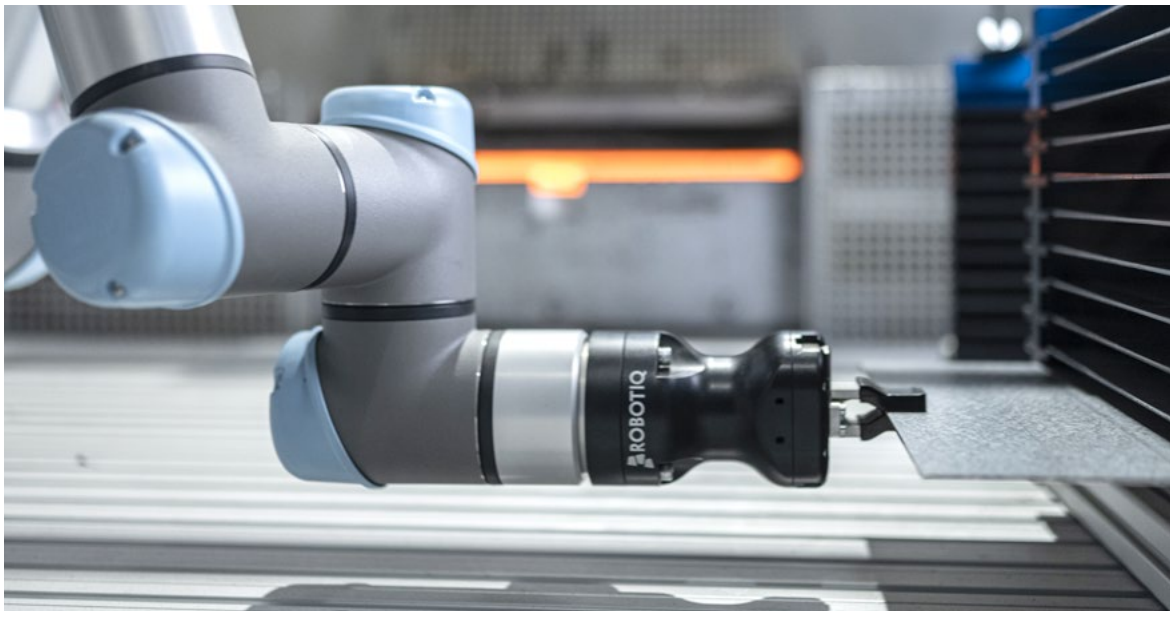
Rüdiger Schorn is Product Manager Hot Forming at thyssenkrupp Steel. He sees a continuing trend in the automotive industry towards the use of hot-formed steels.

At the model lines in Dortmund, thyssenkrupp Steel is simulating the processes used in series production. Good for series production support at the customer.

Being used in the front and rear bumpers, A and B-pillars, side intrusion beams, and various body reinforcements, they ensure that the occupants remain optimally protected in the event of a crash. "The use of hot-formed steels is increasing worldwide in the automotive industry," says Schorn. "Particularly in the newer model series, we can see that the body has a higher proportion of hot-formed components." The Product Manager assumes that electric mobility will further strengthen this trend. This is because the battery must also be well protected in the event of a collision, which in turn places special demands on the design of the surrounding safety structure.

Added to that: with their potential for weight reduction, hot-forming steels help to reduce the vehicle's carbon footprint. Due to its comparatively low CO_2 value, steel has a lower impact on the overall vehicle balance than alternative materials. Additional lightweight steel construction reduces the amount of material used in the component, while maintaining the same performance. This means less steel is produced from the outset, so that even lower climate-damaging emissions are emitted. This effect can be further enhanced by using CO_2-reduced bluemint® Steel.

Against this backdrop, thyssenkrupp Steel has steadily expanded its expertise in the field of hot forming over recent years. On the following pages, we provide insights into current developments, product and process innovations, and services relating to hot forming.



The steel blanks are automatically gripped on the model lines and placed in the furnace.

Web

More about hot-forming steels:
https://www.thyssenkrupp-steel.com/en/products/sheet-coated-products/manganese-boron-steel-for-hot-forming/

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Part I: Material focus

New application perspectives for MBW® steels

The materials specialists at thyssenkrupp Steel are meeting increasing demands in automotive engineering by developing ultra-high-strength materials with differentiated property profiles.

Dr. Cássia Castro Müller (left) and Anastasia Schüssler opened up the innovation process at an early stage, involving customers in order to compare and evaluate technological options for the new material at an early stage.

MBW® 1900 AS Pro: Exploiting lightweight construction potential

MBW® 1900 is at its best when maximum deformation resistance is required in the event of a crash. Boron-alloyed quenched and tempered steel is one of the materials with the highest strength levels currently available. However, the desired property in combination with a standard aluminum-silicon coating also poses specific challenges in the forming process. For this reason, the high-performing product, while ready for series production, was for a long time only available in an uncoated version – limiting its possible uses in motor vehicles. That changed in summer 2020: for the first time, a development team at thyssenkrupp Steel succeeded in modifying the coating concept previously used in such a way as to meet a more specialized requirement profile of the automotive industry as well.

"The task was clearly formulated," recalls project manager Dr. Cássia Castro Müller: "Firstly, we needed to prevent increased hydrogen absorption during the forming process, in order to protect the material from embrittlement. And secondly, we had to ensure that the coated variant did not impair either the forming behavior or the further processing of the material."

Reliable protection against embrittlement

The breakthrough came with AS Pro, a further development of the aluminum-silicon coating used for MBW® steels in the lower strength classes. With AS Pro, a small amount of magnesium is added to the molten metal bath. This has the effect that significantly less hydrogen is formed during the annealing process. Hydrogen can penetrate the material and increase the susceptibility to cracking due to its mobility in the material. "This was very good news for our customers, because it meant that the additional energy and time-consuming measures were no longer necessary in the process," says Cássia Castro Müller.

Other welcome features were revealed during the extensive test and analysis phase. This is because AS Pro not only proved to be a protective shield, but also an enabler for further material and weight savings. Anastasia Schüssler, who took over the commercial management of the project: "Thanks to the novel surface coating, MBW® 1900 AS Pro can now be used in various innovative material and process concepts, for example in tailored blanks or in partial press hardening processes, where we define areas with different strengths in advance. In this way, we achieve further significant weight savings compared to our standard lightweight construction material, MBW® 1500."

Photos: Jennifer Chaaer, Nils Roscher

In the VW ID. Buzz, MBW® 1200 from thyssenkrupp Steel is used as the longitudinal member covering part.

Ready for series production

Perhaps the most important argument in favor of MBW® 1900 AS Pro: the concept for increased crash safety can be processed in existing series production lines without any modifications. To ensure this, thyssenkrupp Steel opened up the innovation process to the outside world at an early stage, involving customers and plant manufacturers, for example. Cássia Castro Müller: "This allowed us to compare and evaluate technological options for the new material at a very early stage." And that paid off: "With the current solution, we can meet many previously incompatible requirements of the automotive industry in the ultra-high-strength range," observes the project manager, summing up.

Web

More about MBW® AS Pro:
www.thyssenkrupp-steel.com/en/as-pro/

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Anastasia Schüßler, product coordinator hot forming, anastasia.schuessler@thyssenkrupp.com

MBW® 1200 + AS: Performance during forming is available with immediate effect

It is a conflict of objectives: the higher the final strength of a manganese-boron steel, the lower its ductility. The following customer example shows how important it is to design the material concept optimally for the respective application. The focus is on the ID. Buzz from Volkswagen, the all-electric successor to the popular "Bulli" transporter. "Volkswagen had actually already decided on a material concept together with our customer, the component supplier Snop," says Sebastian Mieberg, sales engineer at thyssenkrupp Steel. "However, crash simulations showed that the standard hot-formed steel originally planned for the longitudinal member covering part was too hard, and therefore too susceptible to cracking."

Greater ductility required

It was therefore up to Snop to find an alternative without changing the manufacturing process. Among other things, this would have been costly and time-consuming due to the complex adaptations to the tooling. The supplier therefore decided to enter the race with a new material for hot forming that could be used in the stamping shop with existing tooling. The choice fell on MBW® 1200 from thyssenkrupp Steel, and thus on a steel grade that has a higher bending angle compared to the standard. This makes it better suited to absorbing energy in the event of a crash.

Based on material cards, the partners carried out all the necessary digital simulations within a very short time. The result was positive: the material not only met the desired requirement profile in virtual tests, but was also able to prove its qualities on the test bench only a short time later. As a result, MBW® 1200 was approved for series production in the VW ID. Buzz, and has since been used as a longitudinal member covering part in the body of the popular family vehicle.

Fast-paced partnership

The fact that Snop was honored with the VW Supplier Award following the project clearly indicates the value of cross-company cooperation. "We were only able to achieve this flexibility and speed of action through close coordination with our materials partner thyssenkrupp Steel," summarizes Jan Selbach, Senior Director Purchasing at Snop. In fact, it took less than six months from the start of the project until the release of the MBW® 1200 grade for series production in the ID. Buzz. Normally, the test and analysis phase takes about twice as long.

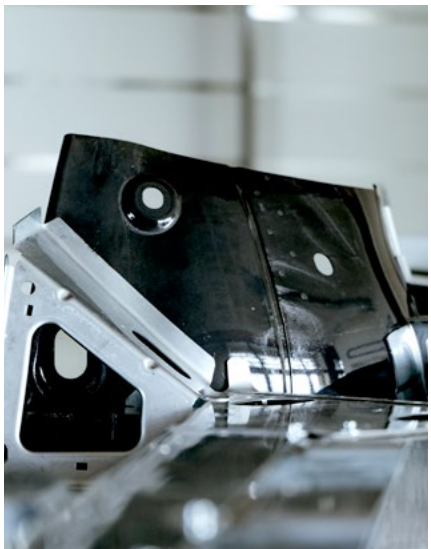
Materials for hot forming

MBW® 1500: Standard hot forming quality, offers high resistance to deformation, ideally suited for safety-relevant components of the passenger compartment

MBW® 1200: Meets higher ductility requirements compared to MBW® 1500, offers impressive spot weld performance in the event of a crash, in combination with MBW® 1900, it is optimally suited for customized manufacturing processes, such as Tailor Welded Blanks (TWB)

MBW® 1900: Maximum potential for weight savings by increasing strength to up to 2000 MPa after hot forming, maximum deformation resistance in the event of a crash, ideally suited for bumpers, side intrusion beams or in laterally loaded cross members

Good to know:
All materials are available in the **CO_2-reduced variant bluemint® Steel.**



Successful cooperation: Snop's longitudinal member covering part won the VW Supplier Award.

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More about the MBW® portfolio:
https://www.thyssenkrupp-steel.com/en/products/mbw/

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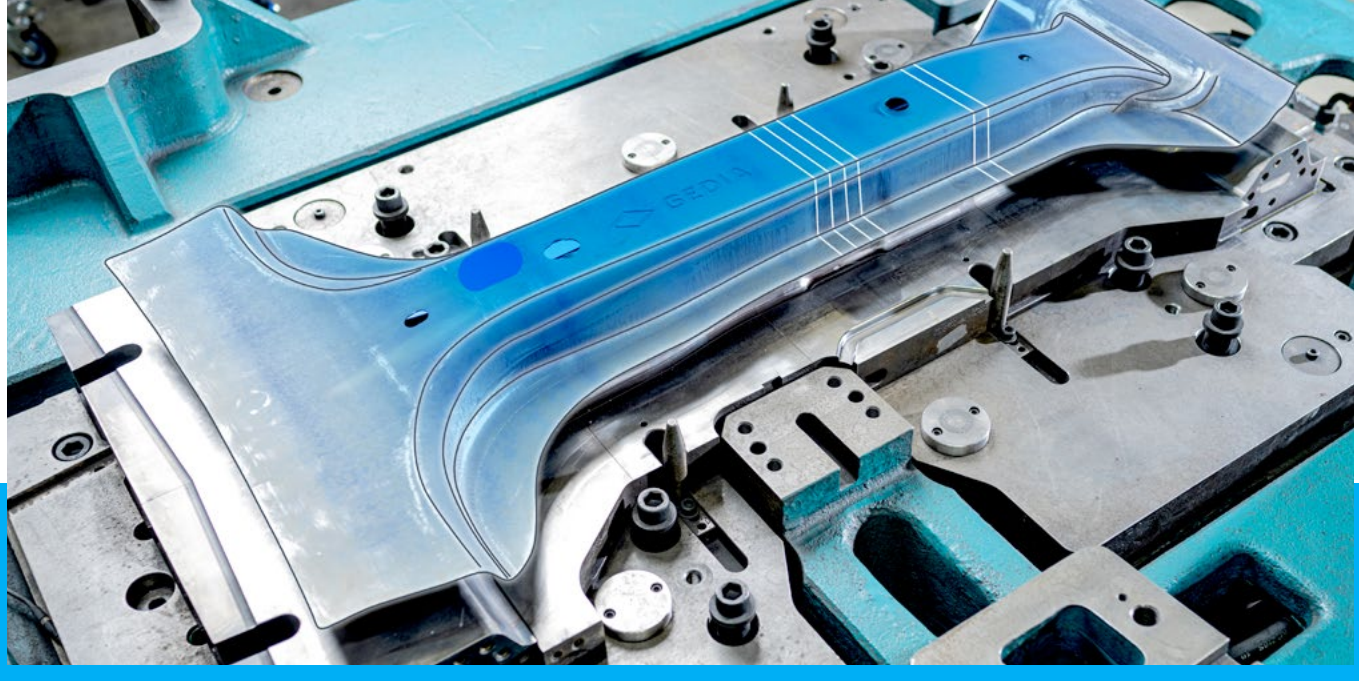

Part II: Analytics focus

Ready for virtual planning processes

The software provider, AutoForm, is now providing comprehensive material cards for using MBW® 1200 + AS and MBW® 1900 AS Pro coated steels in hot forming.

Method planners can draw on a wide range of digital tools when developing and designing forming processes for smooth component production. In particular, this includes simulation programs for detailed representation of the forming tools and their kinematics, as well as the material behavior in hot forming: from heating and machining to the cooling process. The subsequent performance properties of the steel used can also be calculated in advance using appropriate simulation programs, and a corresponding material description. The data on which this virtual process design is based comes from the material cards – digital profiles that describe the properties of a material in detail.

"Only if method planners have suitable forming material cards can they design a suitable forming process at an early stage of development, one that guarantees a component can be manufactured, while at the same ensuring that the requirements for the final component properties are met," observes Dr. Stéphane Graff from the Forming Technology team at thyssenkrupp Steel, summing up the situation. However, a recent search in the database of AutoForm, the leading provider of simulation software for sheet metal forming and body-in-white, revealed a significant gap: more than 1000 material cards for use in cold forming processes were stored there, but there was only one for hot forming. "We wanted to change that," says Dr. Alper Güner, Team Leader Technical Product Management at AutoForm. "Firstly, to respond to the growing importance of this process in the automotive industry. And secondly, to validate the MBW® 1200 + AS and MBW® 1900 AS Pro coated steel grades for use in hot-formed components."

Hardness levels on the test bench

As a result, thyssenkrupp Steel launched a pioneering joint project in March 2023. The other project members are GEDIA Automotive Group, supplier and specialist for lightweight body construction, and AutoForm. "Our cooperation was focused on hardness predictions for press hardening, which were also validated for the tailored tempering process we developed and for the Temper-Box® tempering process used at GEDIA," says Melanie Dinter, sales engineer responsible for product management and launches at thyssenkrupp Steel.

Photos: Nils Roscher und GEDIA Automotive Group

"The patented technology makes it possible to produce components with precisely defined zones of varying strength or ductility in the hot forming tool."

It took around twelve months for the project team to complete its extensive data collection and preparation, the validation tests at laboratory scale and under series production conditions, as well as the corresponding simulation work. Dinter: "Thanks to open discussions and short information pathways, we have been able to react flexibly in this project, and quickly achieve our common goals. It worked, and was enjoyable because our companies have enjoyed a positive working relationship in a spirit of partnership for years."

forming material cards provide reliable results for all press hardening processes, and thus allow design reliability.

For project partner GEDIA, the result really makes work easier. "The better we can assess in advance what works and what doesn't when designing a component, the more accurately we can achieve the desired result. This certainty is also important for establishing innovative materials on the market," says Maik Winderlich, hot forming expert at GEDIA.

In a joint project, Melanie Dinter and Dr. Stéphane Graff (center) from thyssenkrupp Steel, together with Maik Winderlich from GEDIA and experts from AutoForm, have developed material cards for hot forming.

Application technology services

Simulation-based material selection for process design and component use

Validation of all process steps in our own hot forming laboratory close to series production, validation and evaluation of joining technology for suitability for coating

Accompaniment of processing from prototyping to series production

Workshops and seminars on the hot forming portfolio, influencing variables of the hot forming process and material testing (mechanical properties, material structure and effect of hydrogen in the material)

Reliable properties

The meticulous work has paid off: in all cases examined, the hardness values predicted by the simulations matched the values measured in the real tests. Consequently, it is now certain that both materials can be used in standard press hardening processes, as well as in partial press hardening processes in which selected component areas have lower hardness levels. It has also been shown that the jointly developed

Web

More about innovations in steel material:
https://www.thyssenkrupp-steel.com/en/model-and-simulation-facility/

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Part III: Services focus

Shaped blanks from a single source

thyssenkrupp Steel is responding to the dynamic developments in hot forming with smart collaborations. The most recent example is the close cooperation with the steel processor Knauf Interfer Automotive Blanks.

The collaboration between thyssenkrupp Steel and Knauf Interfer is a classic win-win situation: both companies possess specific expertise in the field of hot forming, but it is only when the partners work together that a customized full-service package for the automotive industry is created. "Together, we can provide our customers with shaped blanks, i.e. individually tailored steel parts, from a single source," says Hasan Usta, thyssenkrupp Steel key account manager in the Automotive Sales division. "In this way, we can reduce our customers' procurement costs while continuing to meet all the requirements of series production."

The search for a partner who could cut sheet steel flexibly and reliably lead to Knauf Interfer's door. "We have invested in a new line on which we can produce shaped blanks," explains Thomas Gramann, Plant Manager Presses/Blanking at Knauf Interfer Automotive Blanks. "As a result, we have significantly expanded our expertise in the field of hot forming, which has been very well received in the market." Both the geographical proximity – the main buildings of the two Duisburg-based companies are less than ten kilometers apart – and the long-standing business relationship were reasons to expand the collaboration between thyssenkrupp Steel and Knauf Interfer.

From the idea to the business model

Success was not long in coming: the partners landed their first major joint order in 2023. The total annual volume already amounts to almost one million components; the customer is the component supplier, Snop. While thyssenkrupp Steel is the contractual partner and handles all of the order processing, Knauf Interfer is responsible for the production and logistics of the shaped blanks: The A-pillars and side wall reinforcements that have been ordered are produced in Duisburg using customer-specific tooling, and delivered just-in-time to the Snop plant in Malacky, Slovakia, where the automotive supplier manufactures components for the new model series of its customer, Volkswagen.

"Our customers are highly appreciative of the fact that we are using the current push on the market to enable automotive manufacturers to order their desired materials from us as shaped blanks," says Hasan Usta. The excellent cooperation with Knauf Interfer played a decisive role in this: "The model also works so well for us since our cooperation partner is very familiar with the processes in the automotive industry, and because we are on the same wavelength when it comes to customer service." Is the project-related cooperation between material supplier, Steel Service Center and automotive supplier a model with a future? "In any case," says Domenico Marino, COO of Knauf Interfer. "We are pooling expertise

Together, thyssenkrupp Steel and Knauf Interfer offer shaped blanks, i.e. individually tailored steel parts.

Photos: Jennifer Chaaer, Nils Röscher

Shaped blanks: services at a glance

Advice on material selection

Implementation of all necessary test processes

Manufacture of customer-specific tooling for processing

Manufacture of shaped blanks

Logistical handling (just-in-time, Europe-wide, container management)

and creating new networks together with our partners. By rethinking the supply chain, and thus simplifying the sometimes highly complex processes for automotive manufacturers, we are ensuring the long-term success of all companies involved." And the partners themselves also believe in the success of the model: our order books already contain future purchase orders for more shaped blanks.

Web

More about cooperation in the steel industry:
https://www.thyssenkrupp-steel.com/en/cooperations/

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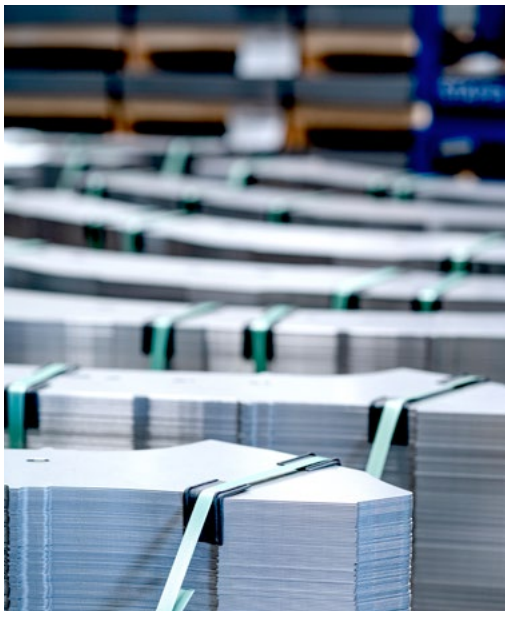
Shaped blanks await delivery to the customer at Knauf Interfer.



3 questions to …

Janko Banik

Project Coordinator Hot Forming
thyssenkrupp Steel

Will the trend towards hot forming continue?
Definitely. Hot forming has made a significant contribution to breaking the weight spiral in automotive construction. Thanks to their high strength, hot-formed steels reduce material requirements and save valuable resources. At the same time, they meet increased requirements in terms of occupant safety. All of this suggests that hot-forming steels will continue to establish themselves on the market.

How is thyssenkrupp Steel dealing with these developments?
We have continuously expanded our expertise in hot forming, and we now offer our customers a comprehensive portfolio of materials and services. For example, we can simulate the processes used in series production on our model lines in Dortmund. This means we can provide our customers with optimum support during development and series production. Partnerships with suppliers such as equipment builders and component suppliers also help us to fulfill complex requirement profiles in the best possible way, all while providing customers with targeted support for the green transformation, for example.

Are further product innovations to be expected?
Control of the process makes it possible to increase the strength and ductility of hot-forming steels further. Overall, the steel development process is far from exhausted. Research is much more networked, so that data and new findings are available faster. This favors innovations, as does the fact that external requirements can change very quickly. As a result, we will certainly bring quite a few more innovations to the market in the steel sector, some of which we cannot even foresee today.

Web

More about hot-forming steels:
https://www.thyssenkrupp-steel.com/en/products/sheet-coated-products/manganese-boron-steel-for-hot-forming/

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