



Future trends and challenges in die casting from a tool steel producer's view

Mumbai, February 15, 2024

- Brief profile Kind&Co
- Trends and challenges in die casting
- Particular challenges for the Indian die casting industry
- Introduction of hot-work tool steels for die casting dies
- Die cast components with highest surface requirements
- Results of industrial applications
- Conclusion

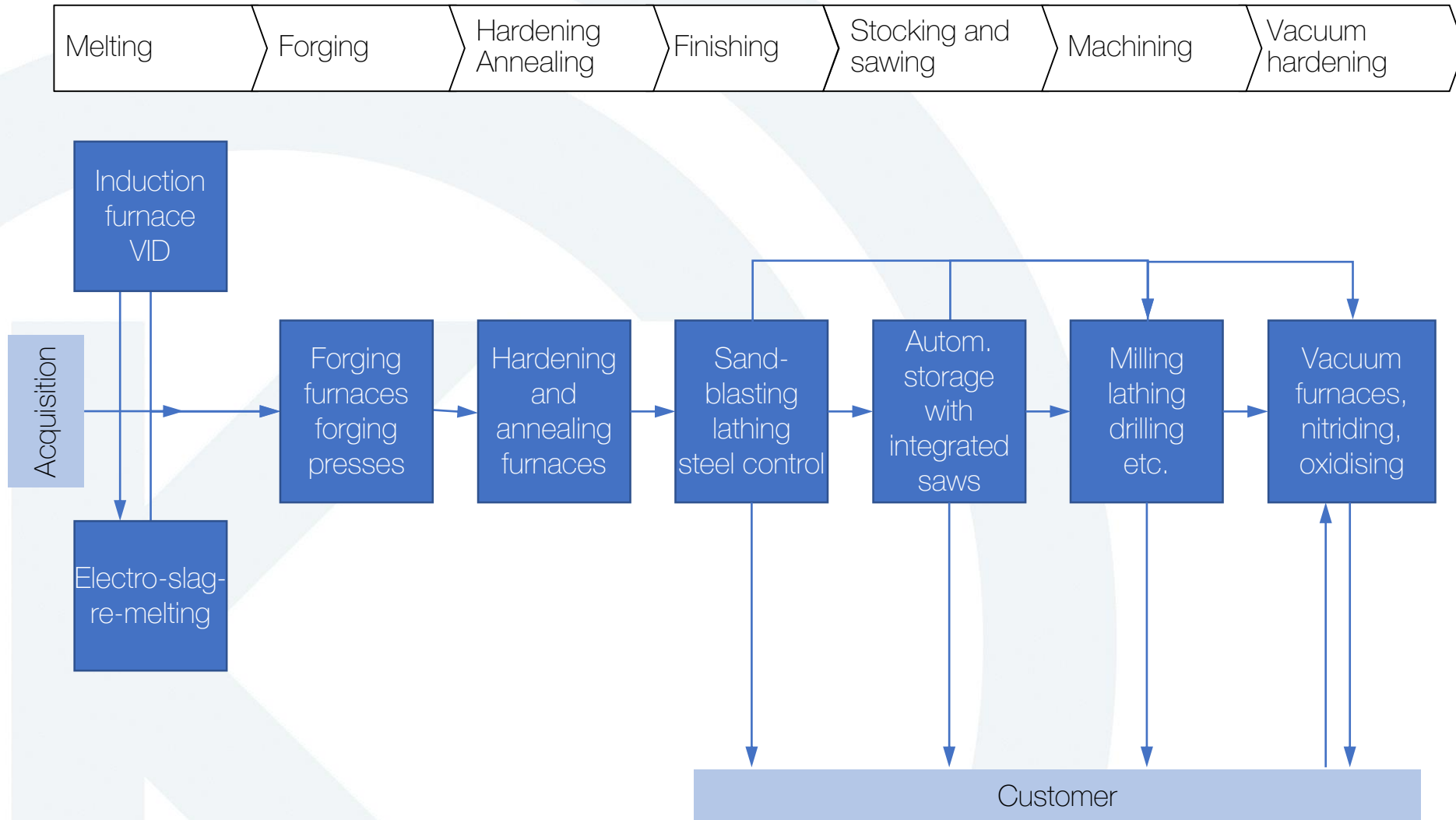


Globally operating hot-work
tool steel specialist

Brief profile Kind&Co

- Continuous production process
- Global network
- Kind&Co and Goel – reliable partners for India

Continuous production process: Expertise in every step of the value chain



Kind&Co Group: Global network with uniformly high service standards



Two strong partners for India



GOEL
STEEL COMPANY
Special Steels - Engineering Services
www.goelsteel.com

Two strong partners for the Indian tool steel market since 2008

Kind&Co accompanies technological changes in the die casting industry

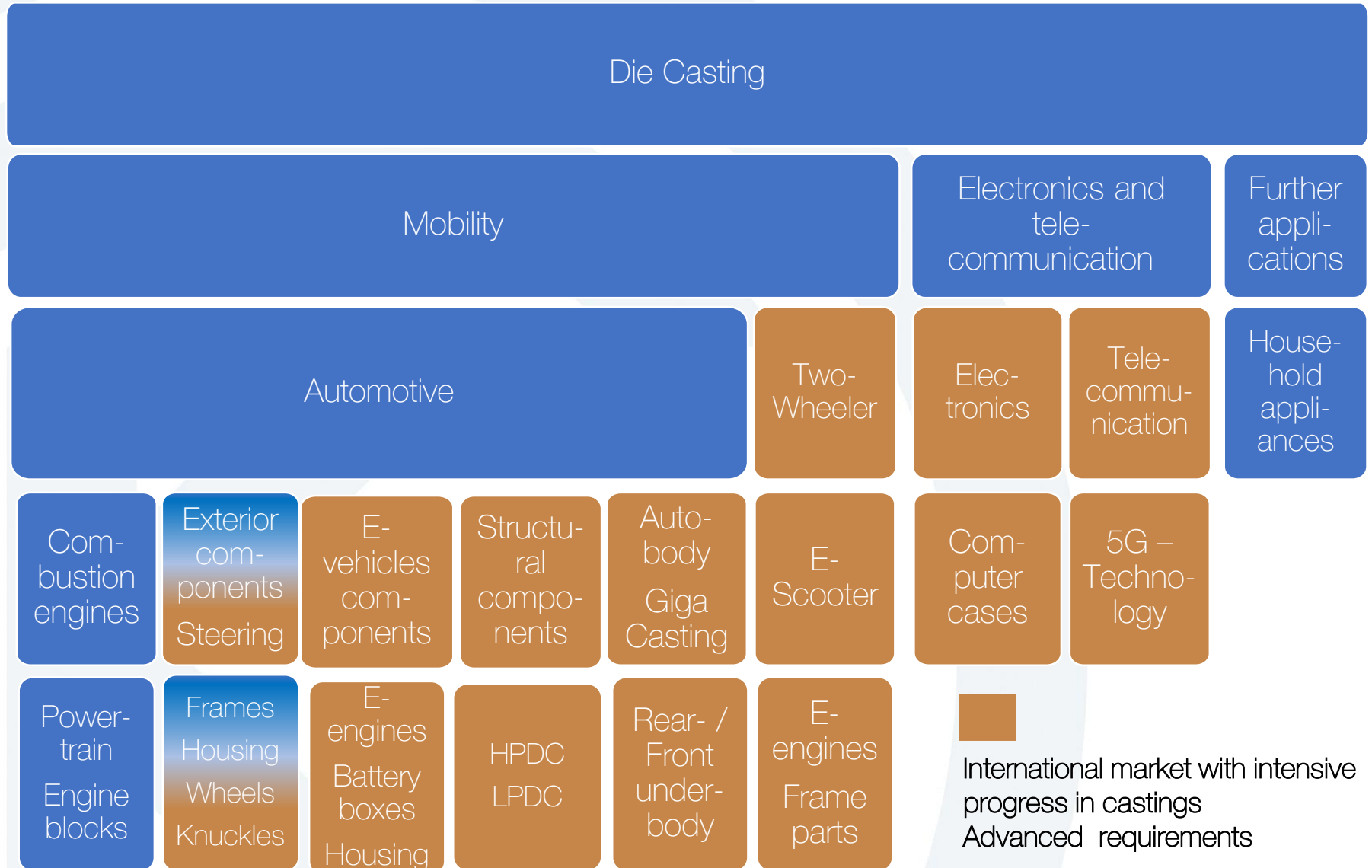
A close-up photograph of a die casting mold. The mold is made of dark, polished metal and features intricate, raised patterns. In the foreground, there is a small, circular, recessed area with a textured surface. The background shows more of the mold's structure, including various ridges and grooves, all under bright, focused lighting.

Trends and challenges in die casting

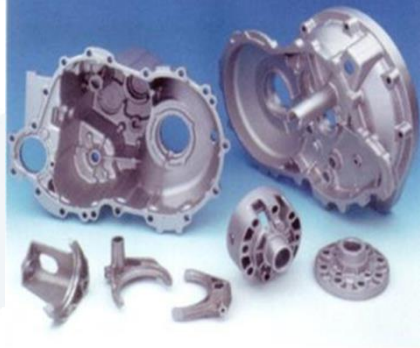
- Die casting serves a wide range of industry branches
- Intensified requirements on surface quality
- Thermal shock cracks limit the lifetime of dies
- Dimensions and shapes of die cast structural components: Challenges during heat treatment and casting

Die casting serves many important industry branches

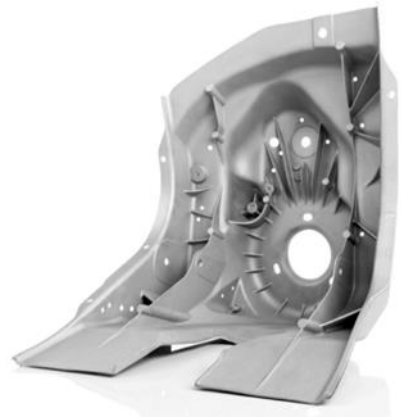
- with progressive requirements for many castings



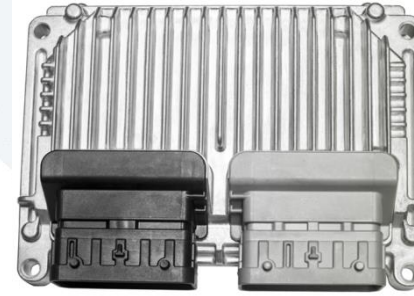
Development of cast products intensifies the requirements on surface quality



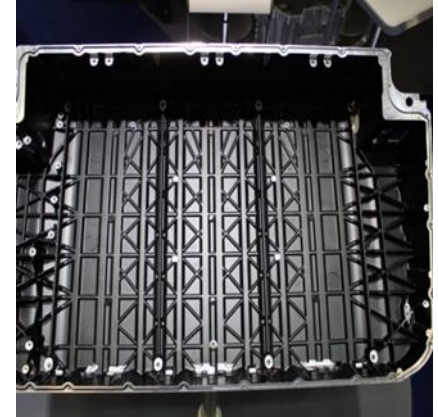
- The volume of classical die cast products like gear boxes and clutch housings will decrease due to modified power concepts.



- Die cast structural components of light metal contribute to weight reduction of modern passenger cars.
- Technical and optical reasons require very high surface quality.

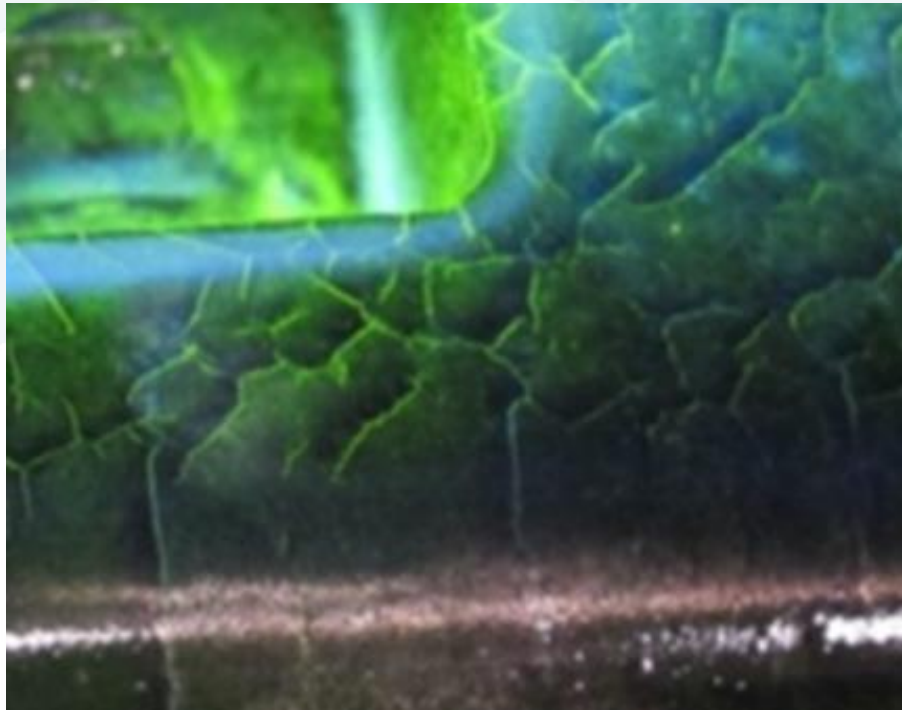


- Due to technical reasons bodies of numerous electronic components must provide highest surface quality.



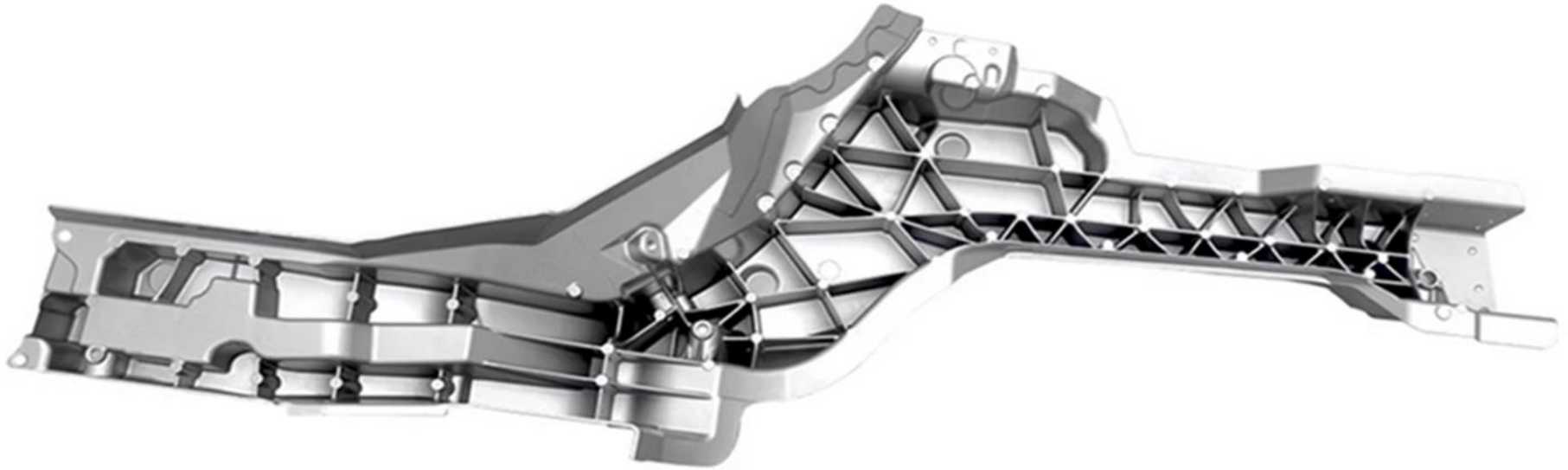
- Battery boxes of electrically driven vehicles must provide highest accuracy within the sealing areas.

Thermal shock cracks limit the lifetime of dies and reduce the quality of castings



- Thermal shock cracks result from the cyclic heating and quenching of the die surface due to the contact with the liquid cast alloy followed by spray cooling.
- Thermal shock cracks limit lifetime of the dies and reduce quality of the castings. They are responsible for 80 % die casting die failures.
- The demands on surface quality, especially visible or mounting surfaces, are already high and will continue to increase.
- Modified cooling technologies such as minimum spray cooling contribute to improved surface quality but require modified cooling concepts.

Dimensions and shapes of die cast structural components: Challenges during heat treatment and casting



- Sharp kinks in the shape of the components are accompanied by corresponding changes in the wall thickness of the dies.
- Inhomogeneous mass distribution or sharp changes in the thickness of die inserts are typical triggers for stress concentrations during the heat treatment and during the casting process.
- Special care must be taken to avoid stress cracks during the hardening process.
- Hot-work tool steels with a high toughness potential reduce the risk of cracking during the casting process.

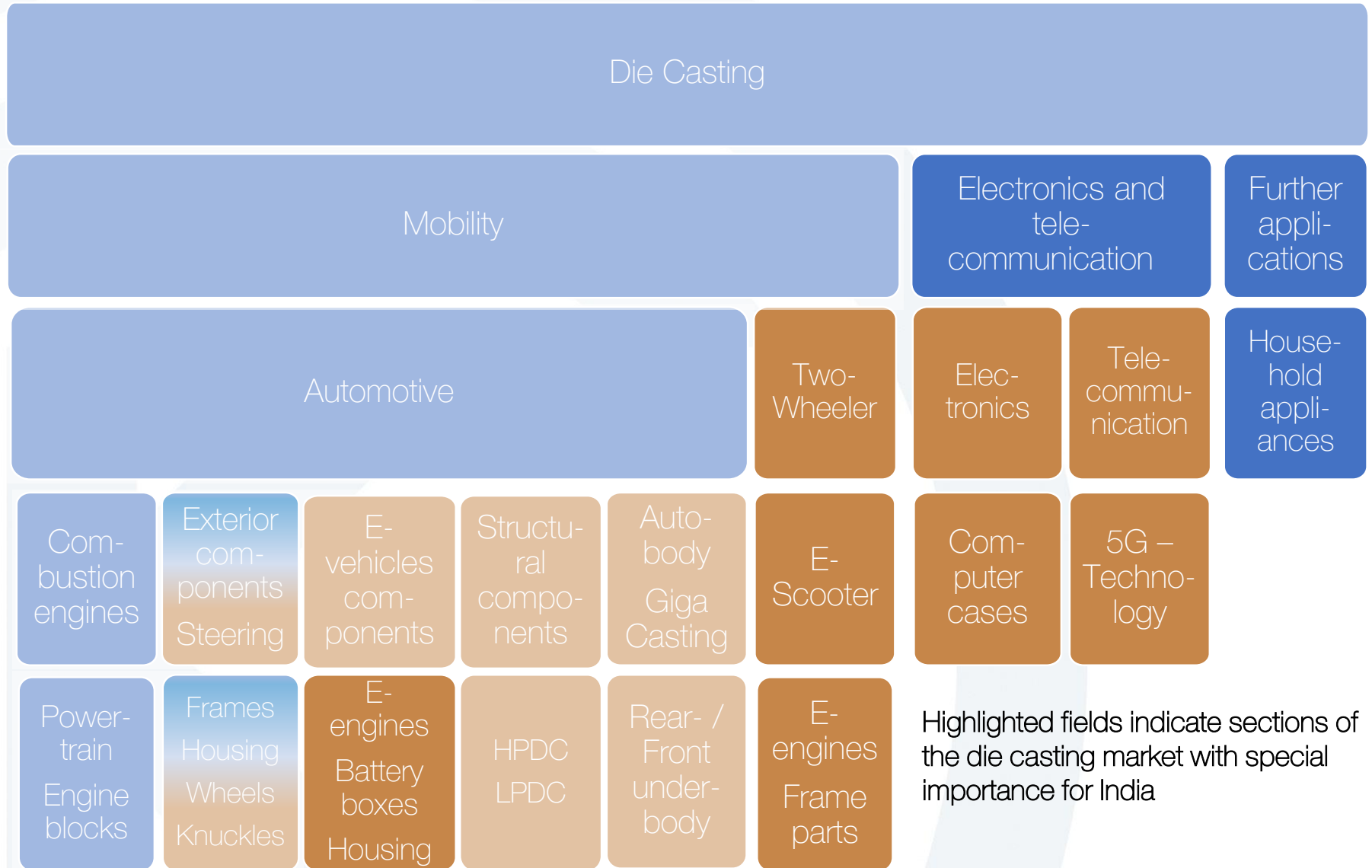
A welder wearing a silver helmet and a grey and yellow protective suit is working on a metal part. The welder is holding a long metal rod and is in the process of welding. The background is a dark, industrial setting.

Kind&Co produces hot-work tool steels
for all die casting applications in India

Particular challenges for the Indian market

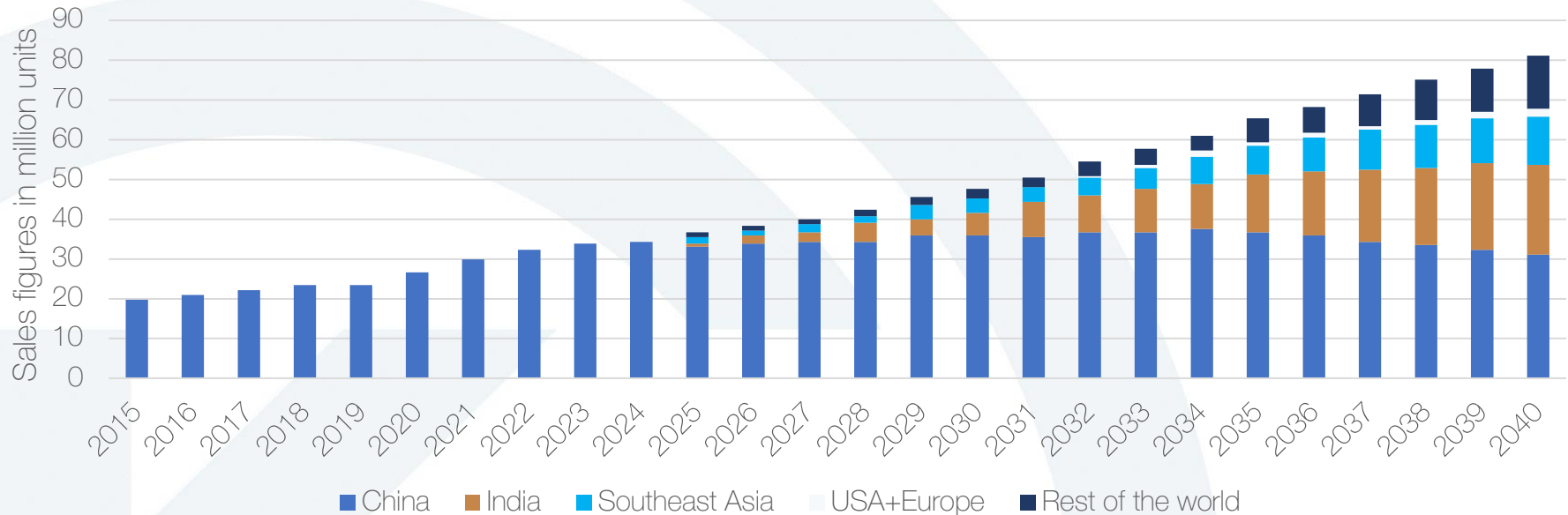
- Portfolio of die cast parts for the Indian market
- Development of two-wheeler market
- Our range of materials for die casting covers even the most demanding requirements

The Indian die casting market is characterized by small and medium sized parts for the domestic market

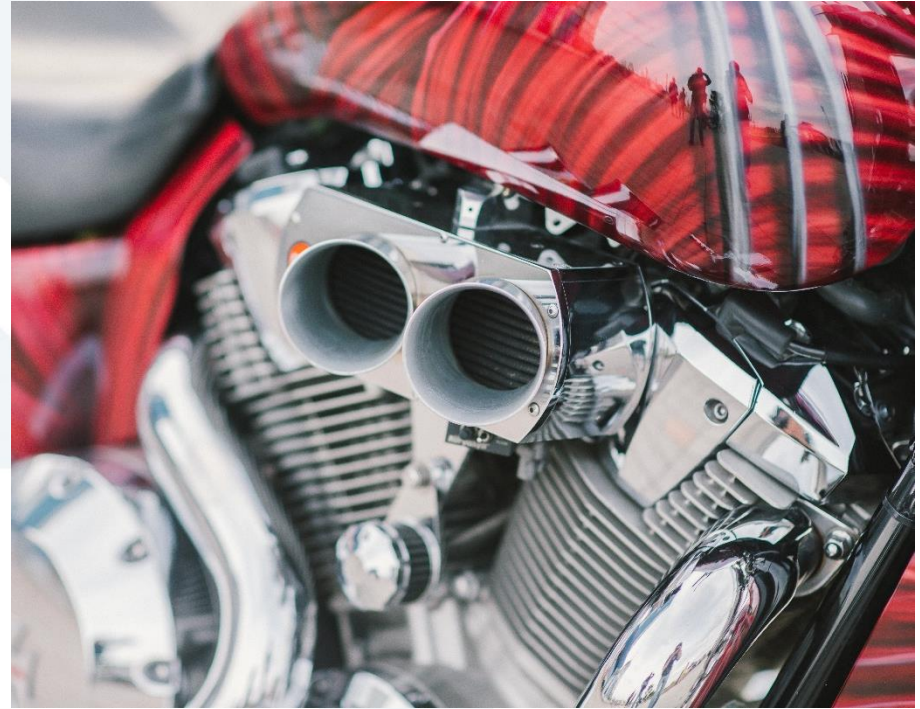


Asia dominates the e-two-wheeler market in the next few years

Development of sales figures - e-two-wheeler



- Supported by government regulations, China currently accounts for over 90% of e-two-wheeler sales.
- India is a country with a traditionally very high portion of two-wheelers on the road traffic. In particular, after 2025, there will be strong growth in the markets of India, Southeast Asia and the rest of the world driven by increasing environmental requirements.
- This development will trigger a growing demand of premium die cast products.

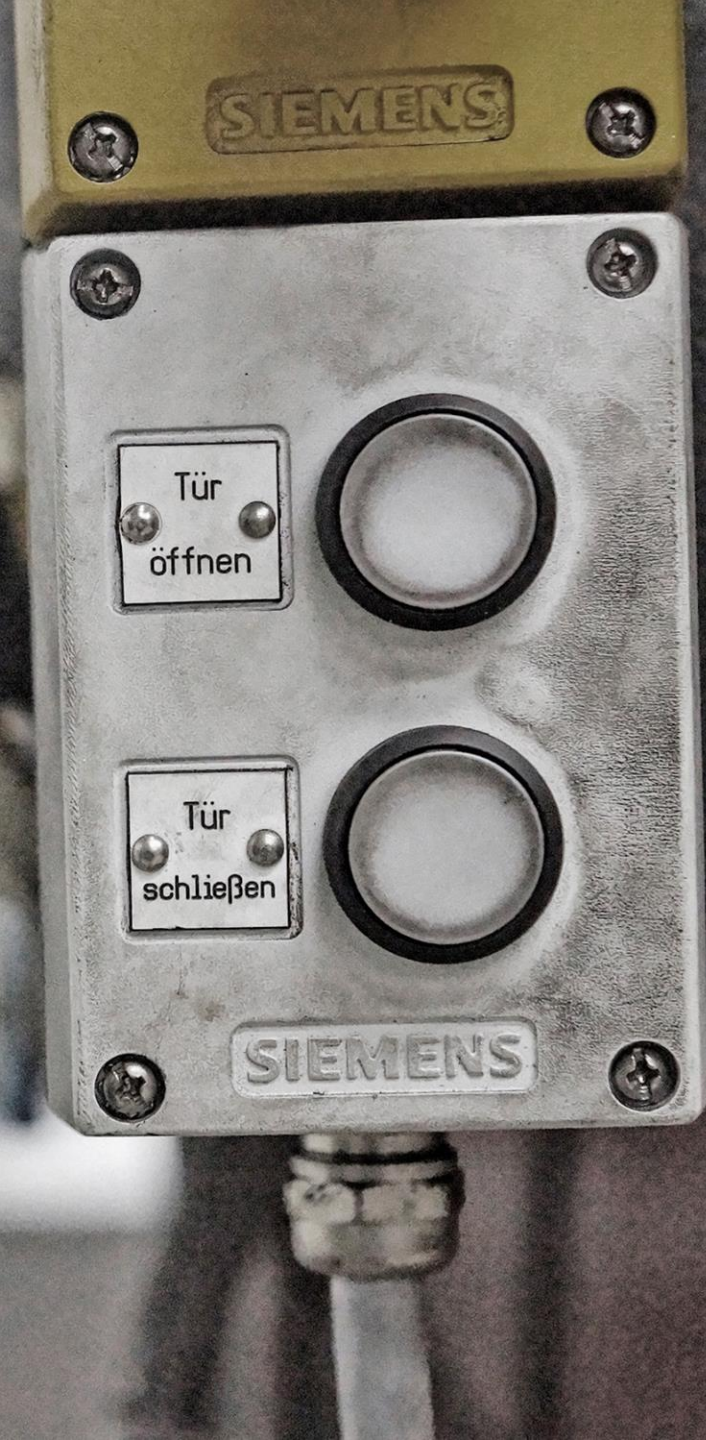


- The development in the two-wheeler industry demonstrates a clear tendency from purely functional towards functional and aesthetic parts.
- Number, shape, and design of die cast products for a two-wheeler have changed significantly.

Kind&Co provides die material solutions
for all sophisticated applications

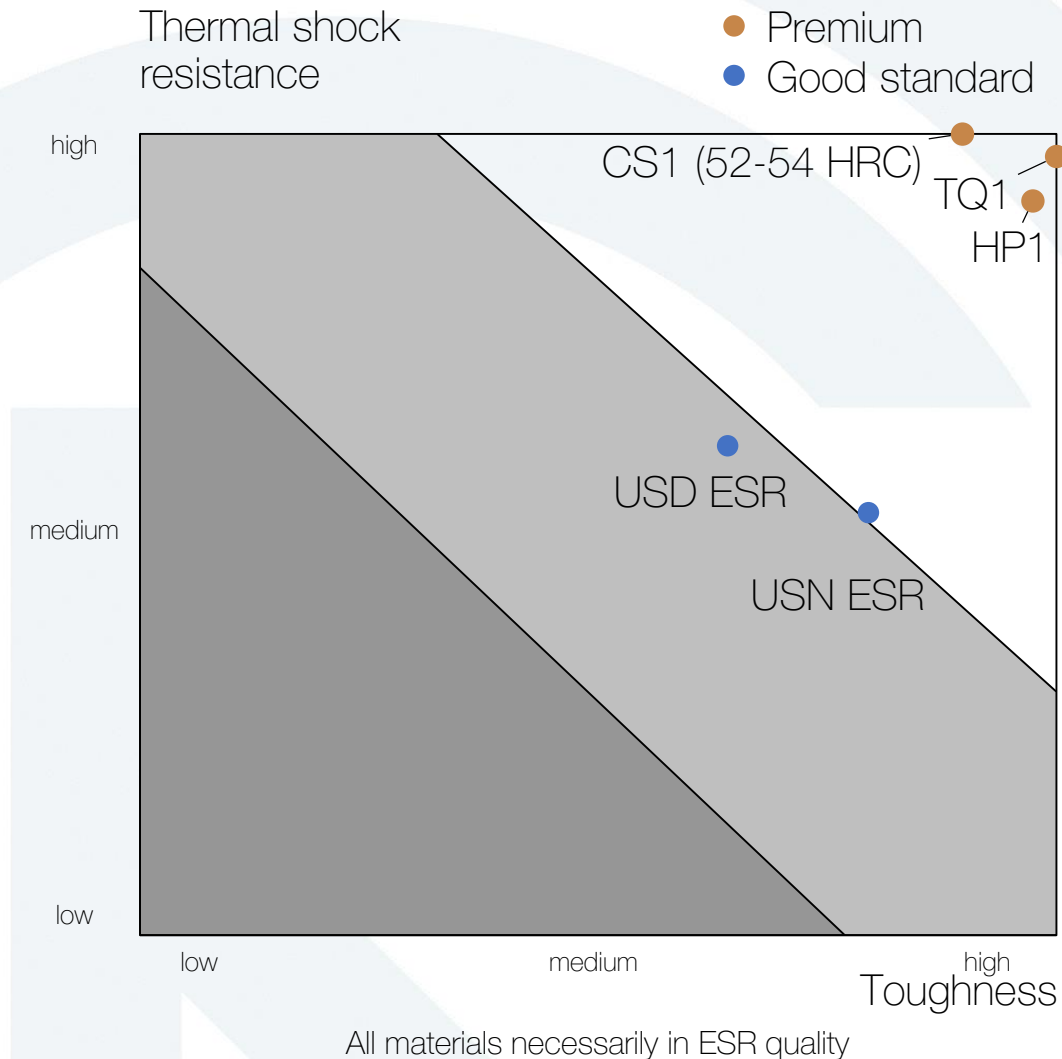
Tool steel solutions for die casting in India

- Tool steel range and requirements
- USN ESR and USD ESR
- HP1
- TQ1
- CS1



Our range of materials for die casting covers even the most demanding requirements

Material overview

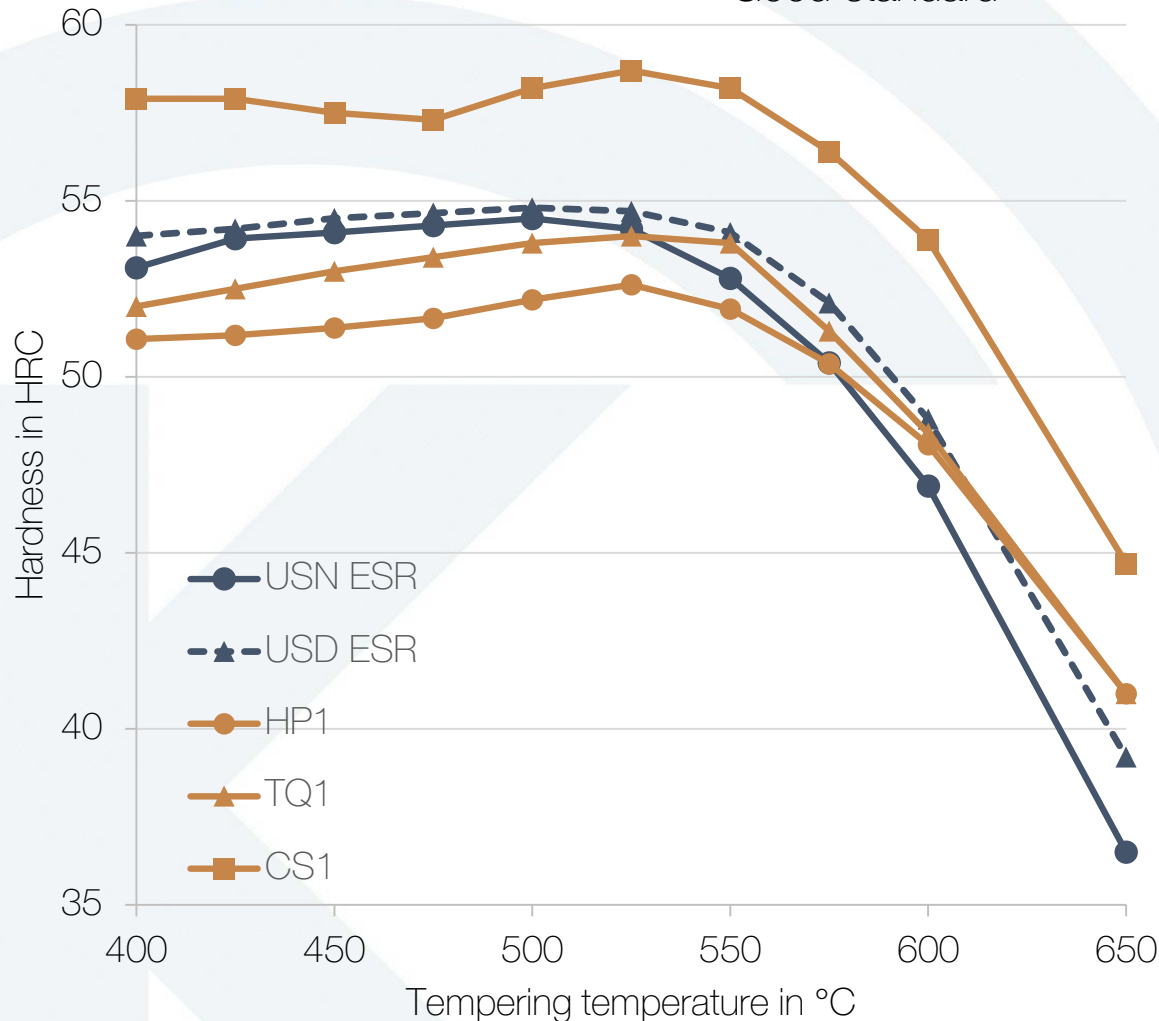


- Thermal shock resistance and toughness are the main properties influencing the die life.
- In addition to standardized hot-work tool steels, which are produced at Kind&Co in excellent quality (blue), we also offer our own premium materials (orange).
- Our premium grades are tailor-made solutions for the increasing demands of the die casting industry.

Premium hot-work-tool steel CS1 shows particularly good tempering resistance.

Comparison tempering curves

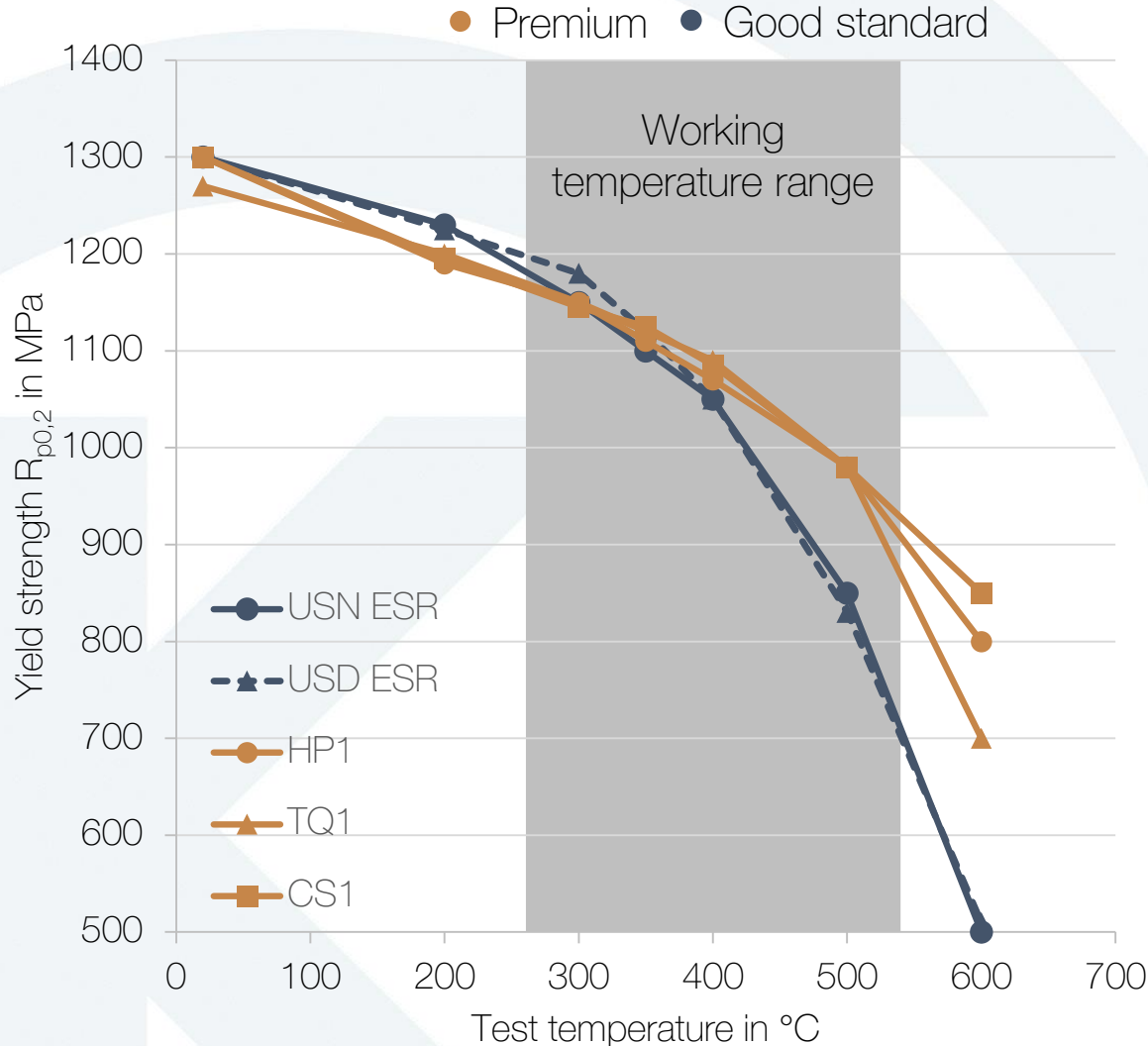
● Premium
● Good standard



- Tempering curves allow a comparative estimation of the tempering resistance of the steels.
- CS1 shows highest tempering resistance
- USN, USD, HP1 and TQ1 are (roughly in this order) in a good medium range of tempering resistance

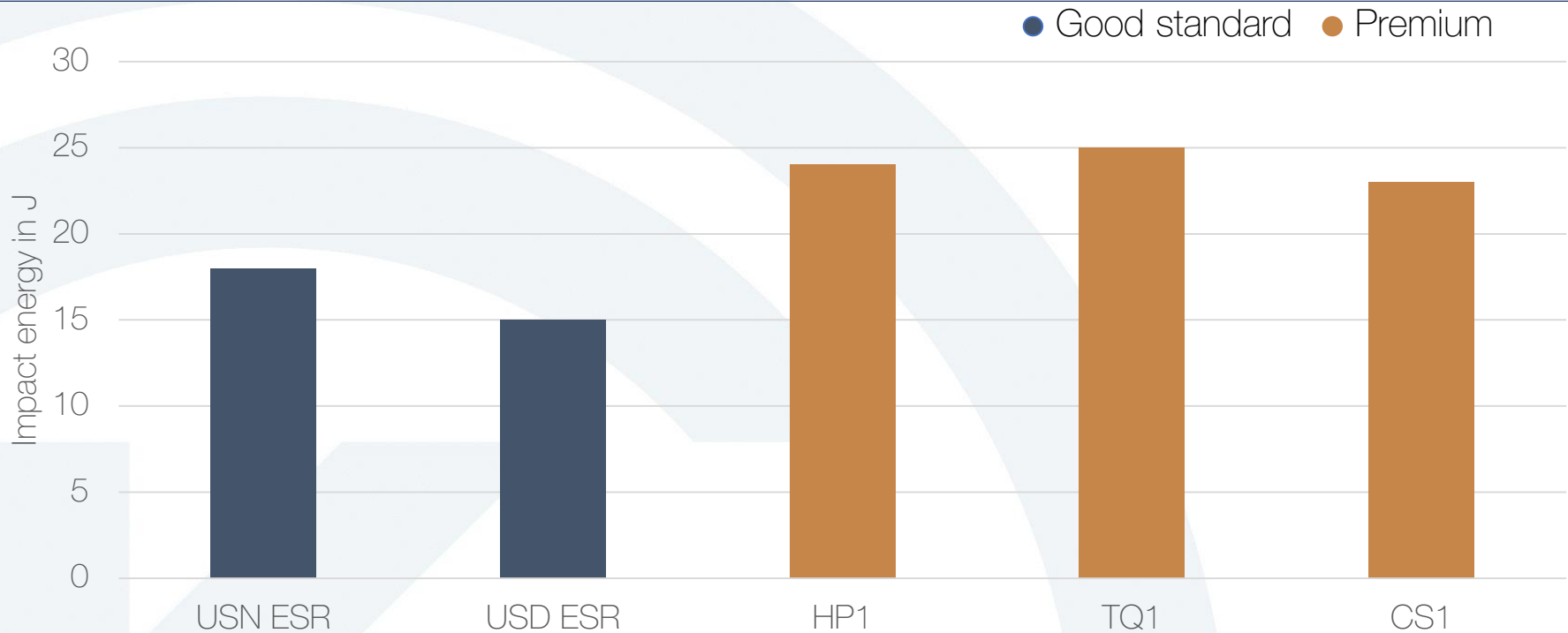
At higher operating temperatures, TQ1, HP1 and CS1 demonstrate their high-temperature strength

Comparison of high-temperature strength



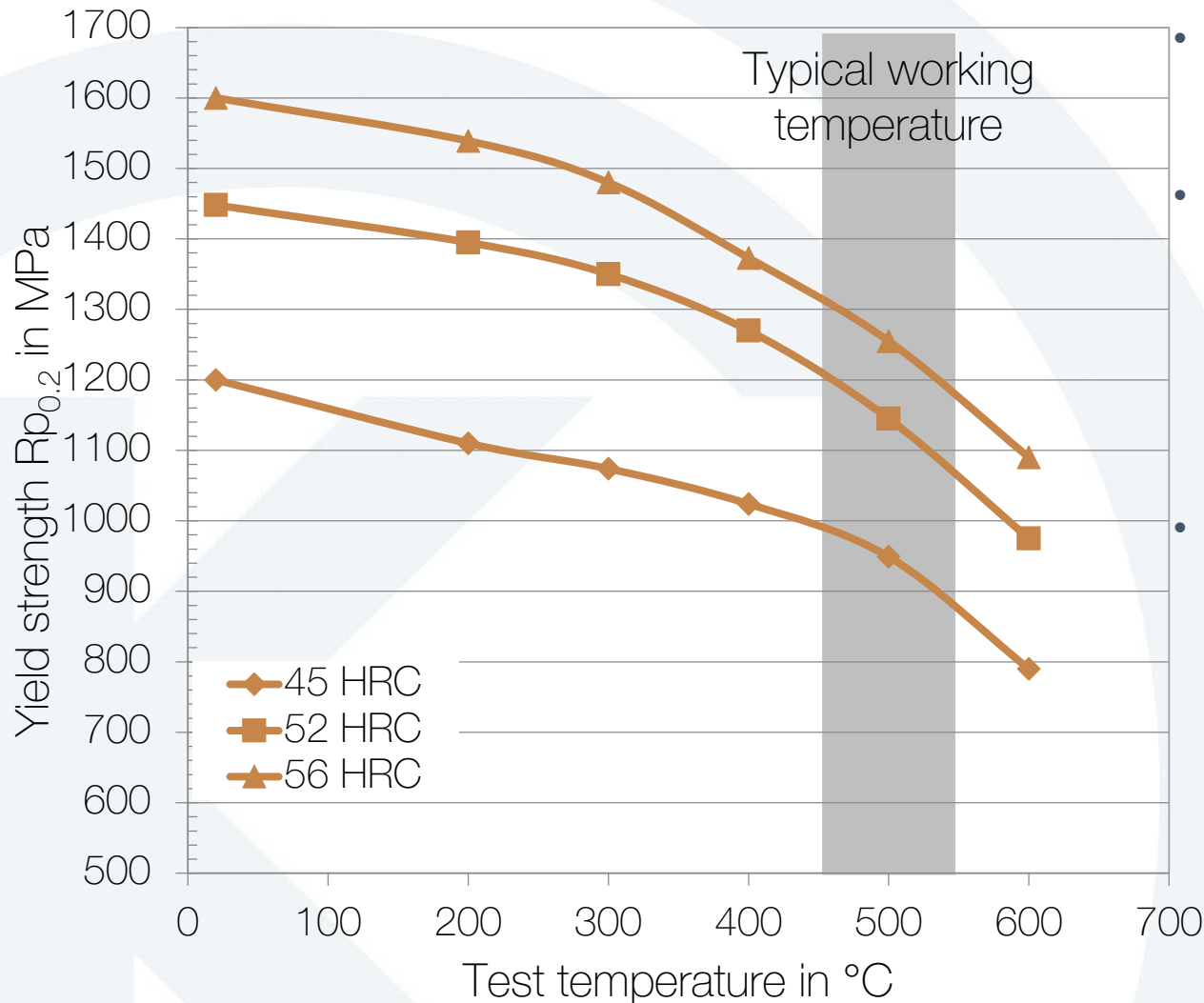
- The steels shown behave identically in terms of their high-temperature strength - represented by the 0.2% yield strength $R_{p0,2}$ - up to a test temperature of approx. 350 °C.
- At further increasing test temperatures (in the range of typical working temperatures), the premium hot-work tool steels TQ1, HP1 and CS1 prove their higher high-temperature strength.

The abrupt stress on the dies must be compensated by high toughness



- The impact energy values shown for ISO-V notched bar impact specimens, measured at RT on transverse specimens from the core of \varnothing 320 mm, apply to the hardness of 45 HRC and describe the toughness of the steels.
- Exception: The premium steel CS1 achieves its high impact strength shown here at a hardness of 52-54 HRC!
- All steels shown here are manufactured using the ESR process.

The alloy concept of CS1 allows a working hardness of up to 56 HRC



- The alloy of CS1 allows hardness values up to 56 HRC.
- In addition to the improved heat crack resistance, a higher working hardness also allows the flexible adjustment of the material with regard to wear resistance.
- The CS1 hardness window available for optimization is well above the hardness window of standard materials.

HP1 – for highest loads in medium sized die inserts



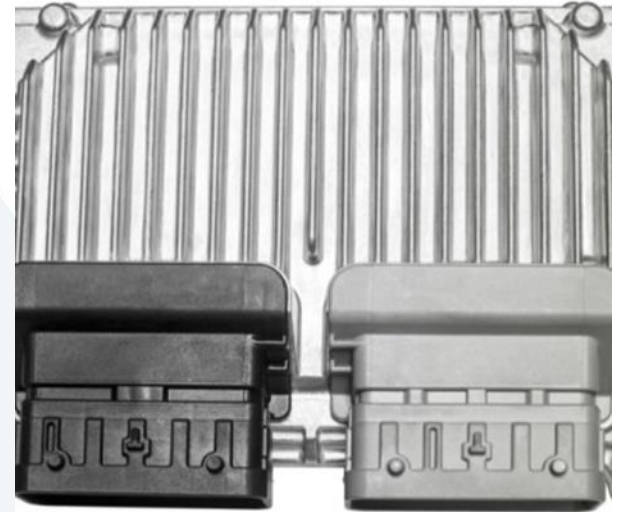
- The premium steel HP1 for die casting combines tailor-made properties with cost-effectiveness. For dies for highest loads and narrow tolerances (cooling fins, sealing surfaces) up to medium insert sizes.
- HP1 has proved its suitability in the production of battery boxes for electrically driven cars :
 - Compared to 1.2344 (AISI H13) drastically improved surface quality in the sealing grooves.
 - Reduced maintenance efforts lowering the production cost

TQ1 offers many advantages for the user



- The best quality for tool steel in die casting.
- For tools exposed to extreme conditions - large tools for vehicle components, tools for components in electric motor vehicles (e.g. battery housings) and dies exposed to very high flow rates.
- Recommended for minimal quantity spraying

CS1-the premium steel for highest surface requirements and forming tolerances in die casting

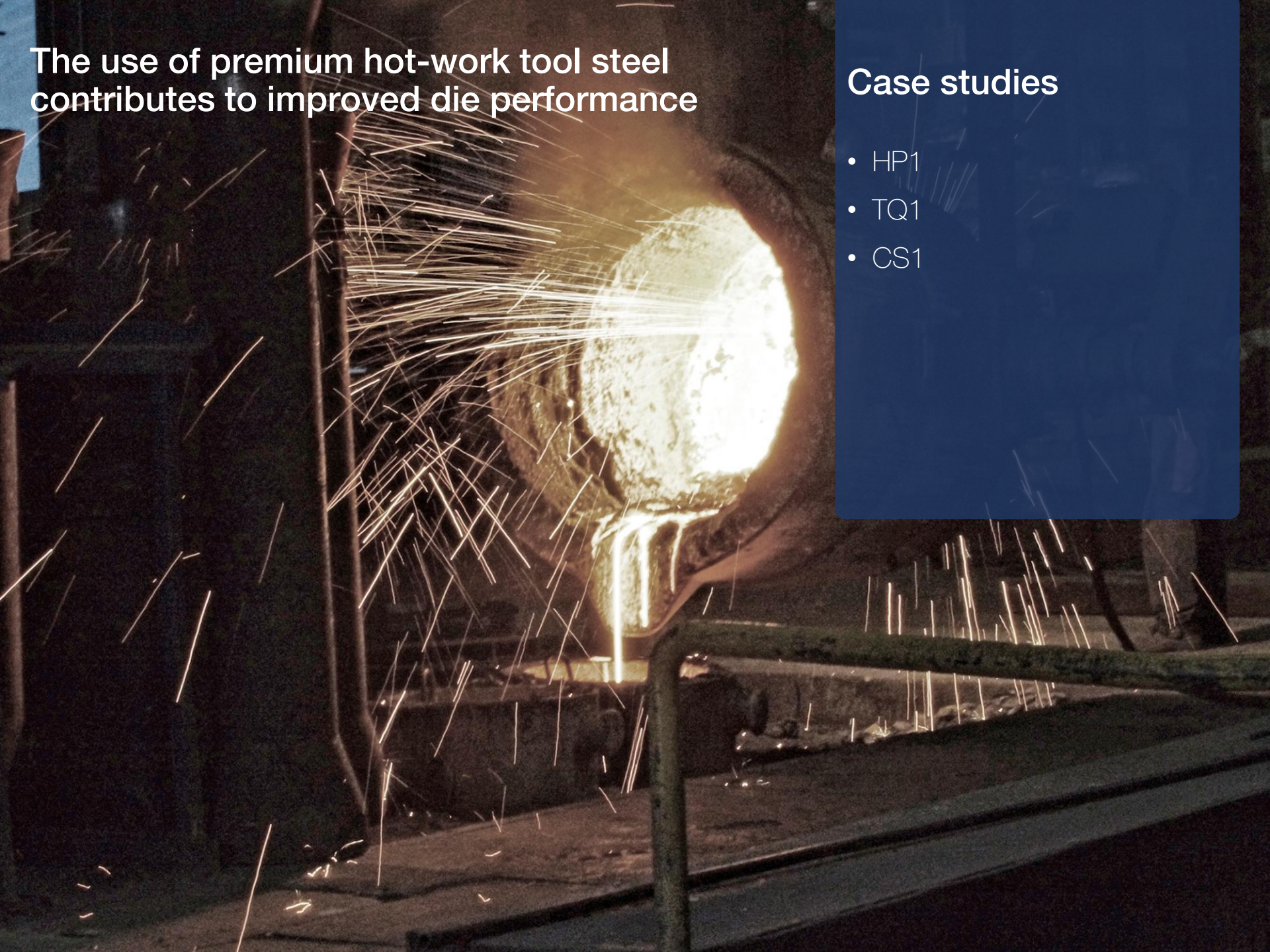


- CS1 is a unique steel which has proved its advantages for castings with aesthetic surface finish, and highest marked dimensional stability in near net shape casting processes.
- CS1 improves part quality by prevention of premature heat checks due to excellent thermal shock resistance and higher yield strength at die working hardness above 50 HRC
- CS1 provides safety against overstressing due to outstanding toughness at elevated hardness levels
- CS1 supports the die caster in cost-effective production, avoiding costly reworking steps

The use of premium hot-work tool steel contributes to improved die performance

Case studies

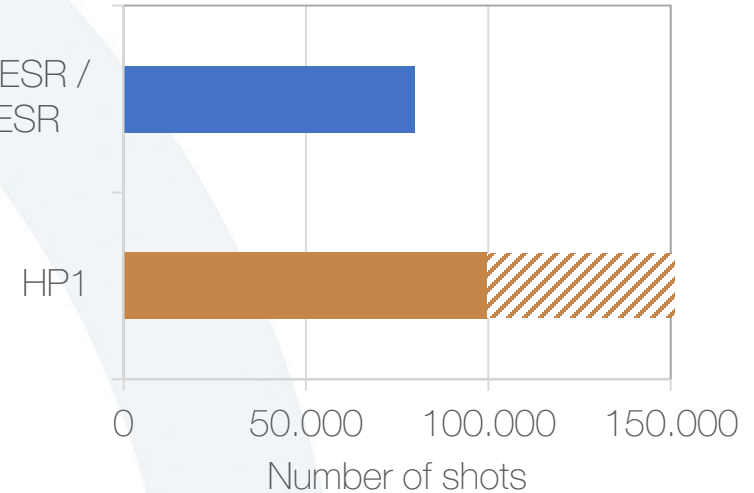
- HP1
- TQ1
- CS1



Case study: HP1 significantly extends die service life



1.2344 ESR /
H13 ESR



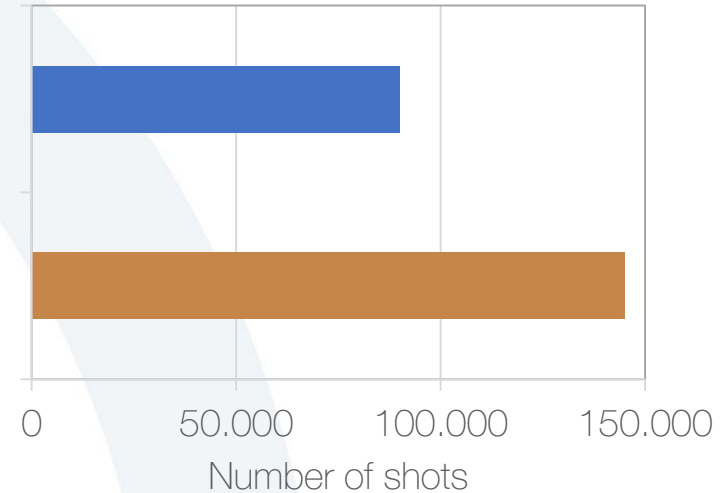
- Product: Automotive part
- Requirements: high repeatability, high surface requirements, no cracks allowed
- Results: no defect occurred after 100,000 shots

Case study: TQ1 significantly extends die service life



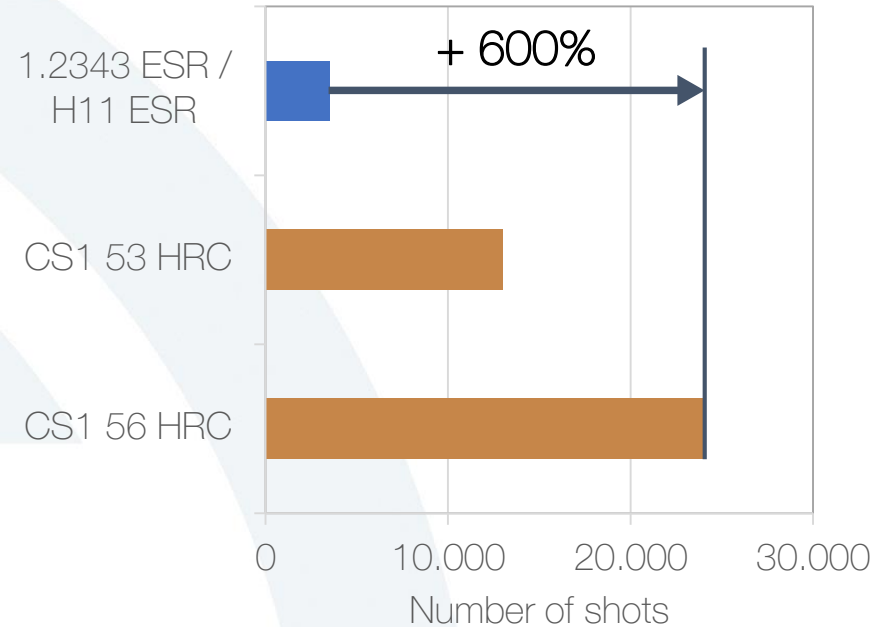
1.2343 ESR /
H11 ESR

TQ1



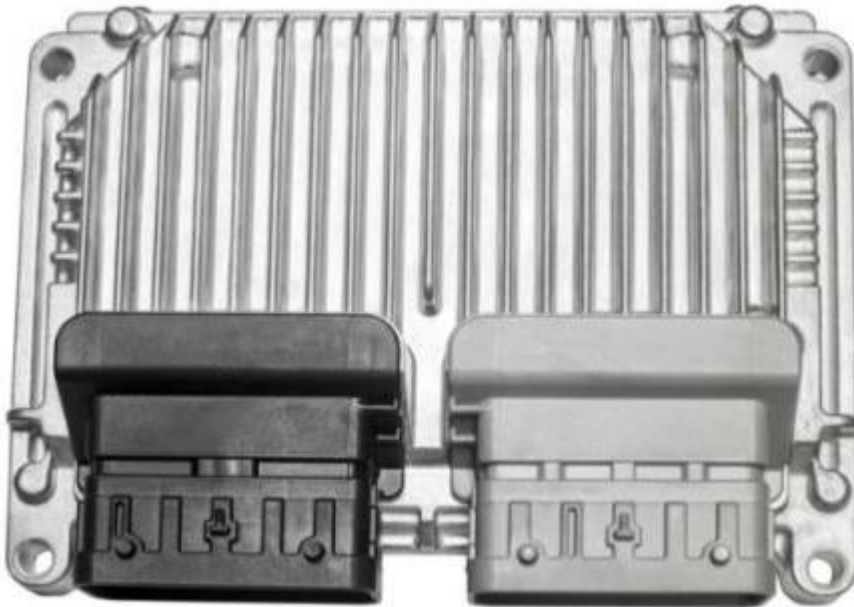
- Product: Shock tower
- Requirements: high repeatability, high surface requirements, no cracks allowed
- Results: Service life improvement of more than 60 % with TQ1

Case study 1: CS1 significantly extends die service life



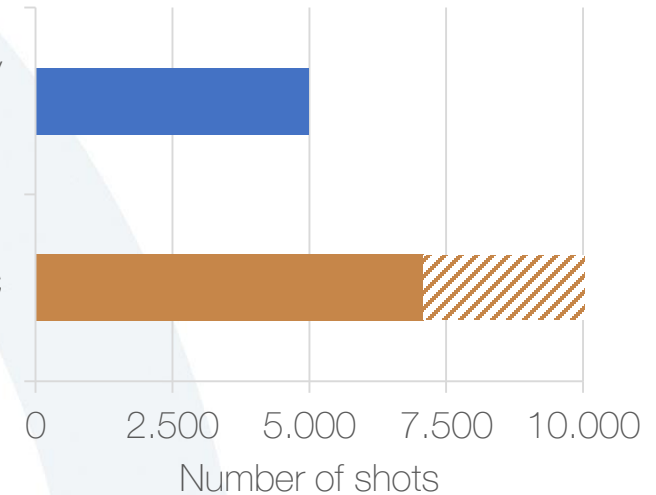
- Product: Motorcycle brake lever holder
- Requirements: very high requirements for sealing and visible surfaces, as castings are painted or chrome-plated, no cracks allowed
- Results: 600% improvement in service life.

Case study 2: Significant increase in die performance due to CS1



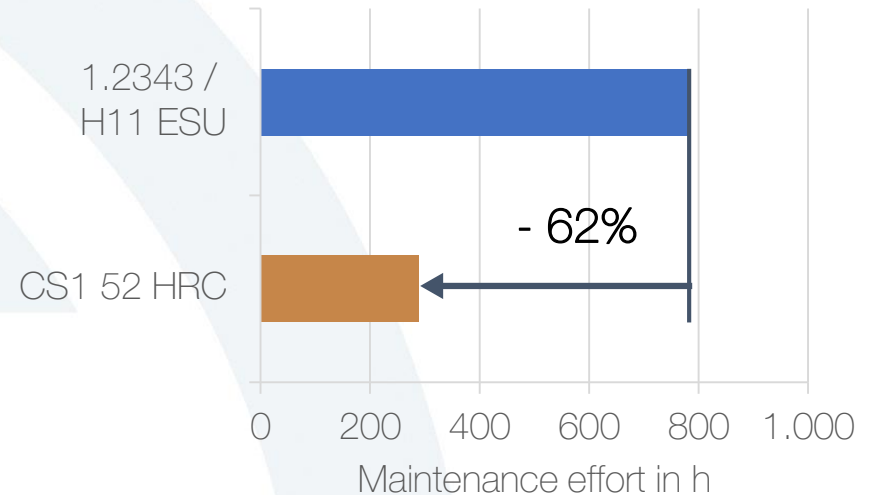
1.2343 ESR /
H11 ESR

CS1 53 HRC



- Product: Housing for storage unit
- Requirements: high dimensional stability, high surface requirements in the sealing area, resistance to cracking at the grooves (ribs can tear off during demolding)
- Results: No defect occurred after 7,100 shots.

Case study 3: CS1 reduces maintenance costs



- Product: Throttle body
- Requirements: high demands on the surface in the area of sealing (cracks due to thermal shock are not tolerated, excessive finishing of the die).
- Results: 90,000 shots for 1.2343/H11 and CS1, average maintenance per die reduced by 62% by using CS1.

- The world-wide die casting industry faces currently enormous challenges regarding size and surface quality of die cast products
- The predicted growth of individual mobility, especially electric two-wheelers, the high demand of the electronics industry for castings with highest surface requirements are challenges for the Indian die casting industry.
- Kind&Co. provides standard and premium hot-work tool steels for all purposes in die casting:
 - USN ESR and USD ESR are internationally standardized hot-work tool steels of the AISI H11- and AISI H13 type, respectively.
 - Our premium grades are tailor-made solutions for the increasing demands of the die casting industry: Improved toughness and high-temperature strength, thermal shock resistance, improved resistance against softening during casting operations.
 - HP1 - The premium steel for die casting that combines tailor-made properties with cost-effectiveness. For dies for highest loads and narrow tolerances (cooling fins, sealing surfaces) up to medium insert sizes.
 - TQ1 - The best quality for tool steel in die casting. For tools exposed to extreme conditions, large tools for structural vehicle components, tools for components in electric motor vehicles (e.g. battery housings) and dies exposed to very high flow rates.
 - CS1 - The solution for die casting of parts with increased demands on surface quality. A hardness of up to 54 HRC is possible. For visible parts in die casting for motorcycles, high-quality consumer products such as laptops, mobile phones and electronic components with the highest demands on surface quality.

Thank you for your attention!



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