



FORGING  
INNOVATIVE  
STEELS FOR  
UPCOMING  
AUTOMOTIVE  
DEMANDS



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**SIDENOR  
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“Sidenor is a market leader in the European special steel long product industry and a reference point for heavy forgings and castings worldwide”



Annual Sales (Tonnes)

**746.000**

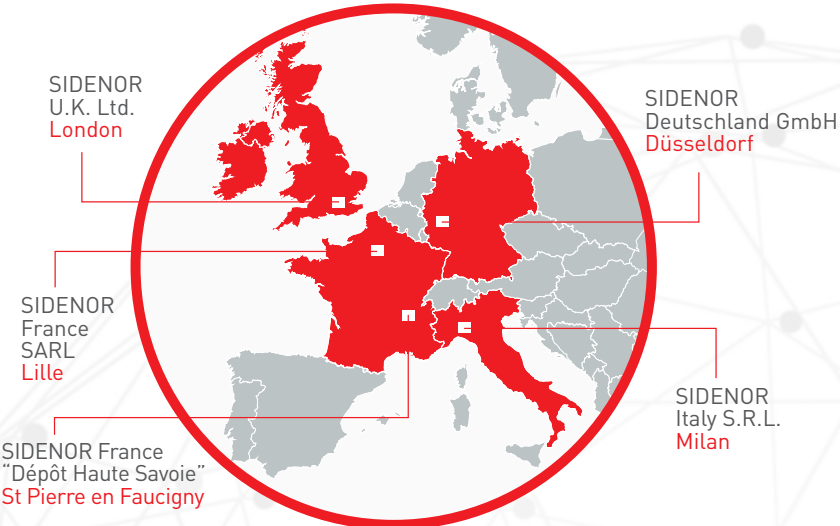
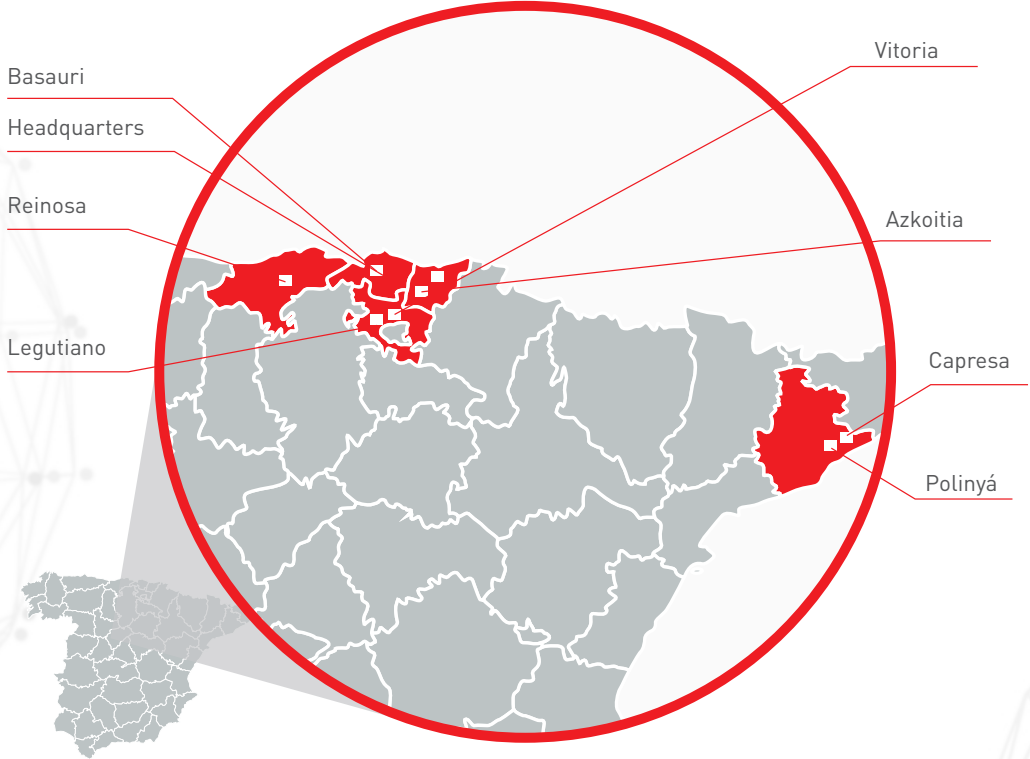
Revenues (mill€)

**722**

Employees

**2.319**

# Manufacturing Centres



“Our mission is to **Create, Develop, Transfer and Protect Sidenor Technology** in order to reach innovative solutions in the production and use of steel materials and steel components”

R&D Laboratory to support Research Activities along the whole production chain

STEELMAKING

METALWORKING

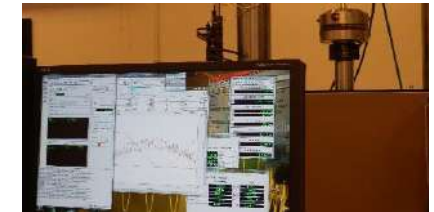
PRODUCT



INDUCTION VACUUM  
MELTING & CASTING FURNACE



THERMAL-MECHANICAL  
SIMULATOR



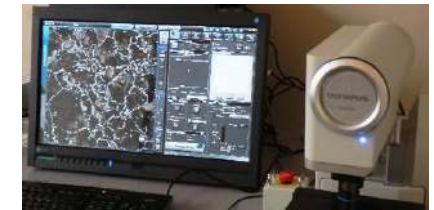
FATIGUE TESTING



FIELD EMISSION  
ELECTRON MICROSCOPE

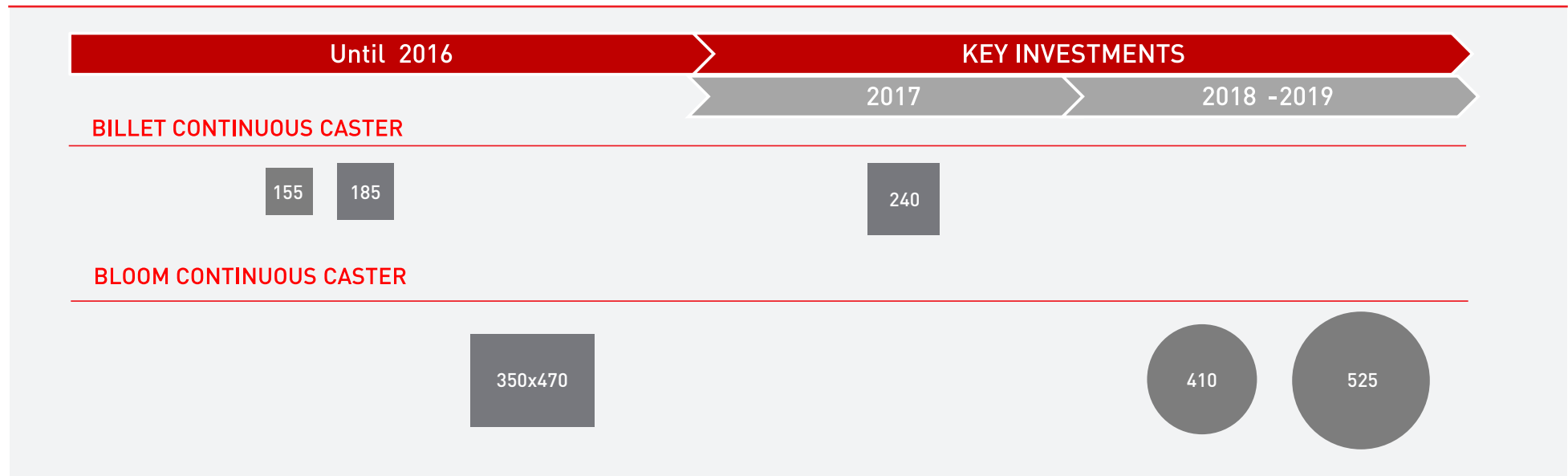


DILATOMETER



OPTO-DIGITAL  
MICROSCOPES

“In the spirit of continuous improvement of its processes, facilities and product portfolio, Sidenor decided to invest in the Continuous Casters. The new formats will allow the company to reach new market shares and offer new products and specific solutions for individual customers”





### Products



#### HOT ROLLED BARS

- Rounds
- RCS
- Flats



#### WIRE ROD

- Coils



#### FORGED BARS

- Rounds
- RCS
- Flats



#### BRIGHT BARS

- Drawn
- Turned
- Ground



#### DRAWN WIRE

### Applications Automotive



- Crankshafts
- Gears
- Common Rails
- Leaf Springs



- Coil Springs
- Bearings
- Shafts
- CVJ's



- Steering Racks
- Steering Pinions
- Shock absorbers
- Fasteners

### Applications Non-Automotive



#### ENERGY (OIL & GAS)



#### ENERGY (WIND POWER)

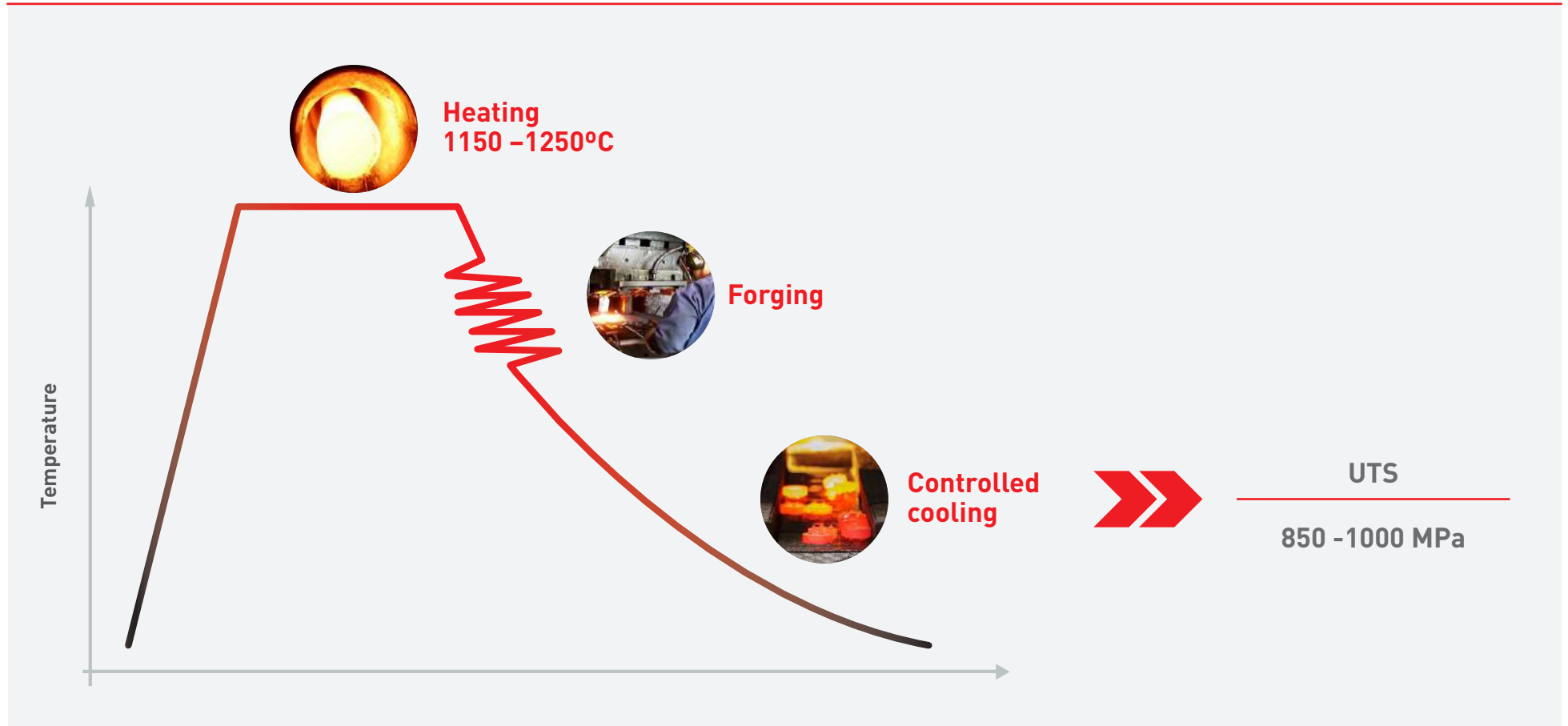


#### RAILWAY



#### OFF HIGHWAY EQUIPMENT

### Hot forging steps

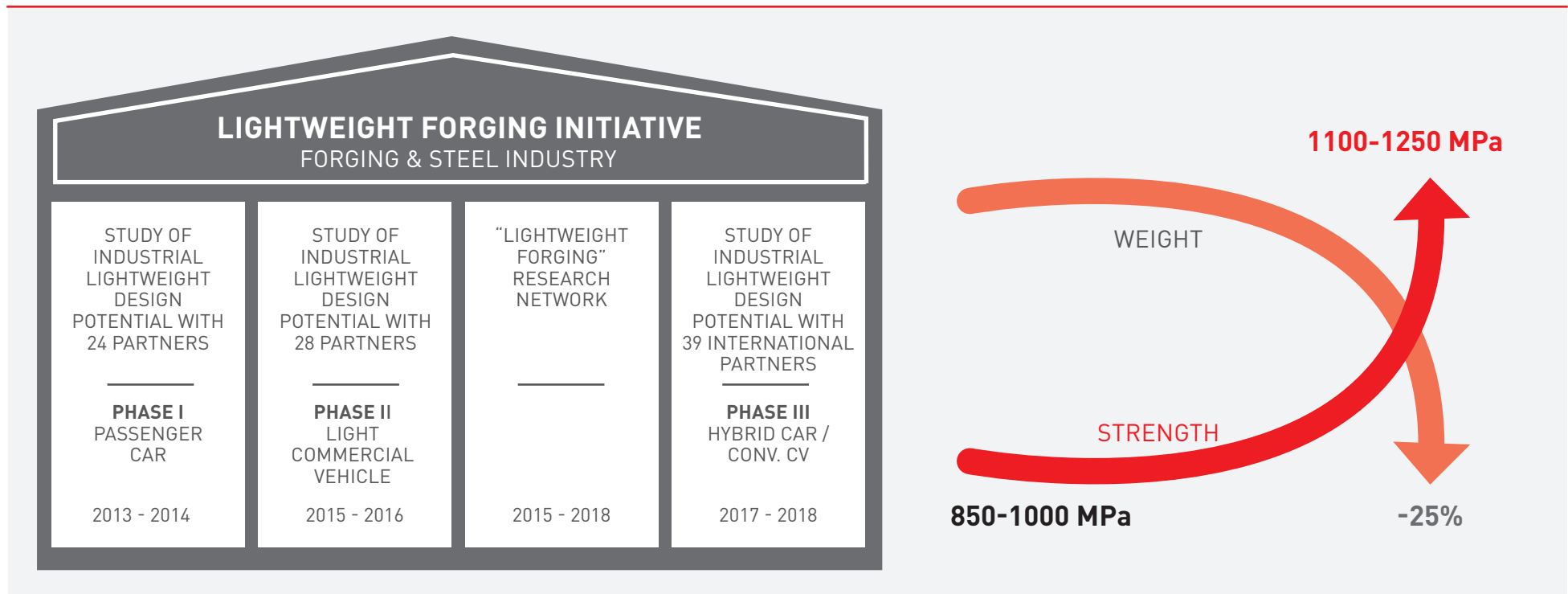




## Weight Reduction is a Must



- Weight reduction of forged components saves fuel consumption, reduces emissions and helps to fulfill EU Directives.
- An increase of steel strength allows weight lightening in similar proportion.



SIDENOR gives solutions to present and future customer's demands and challenges by means of own product developments:

### MICRO 1100 HE

- Microalloyed Steel with high yield strength and fatigue performance after forging or rolling



- Ferrite-Pearlite

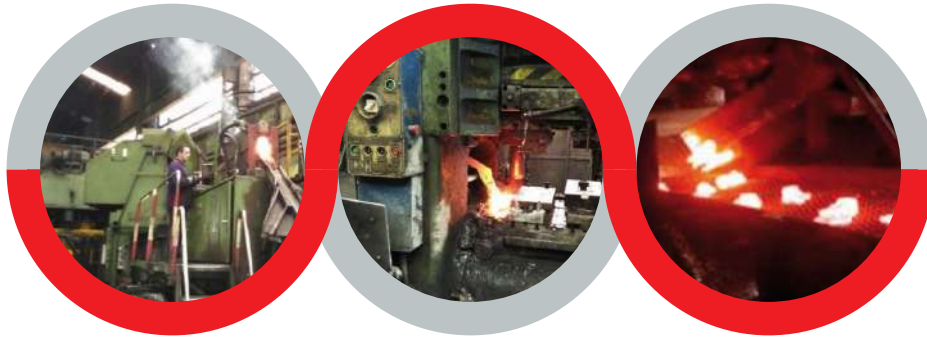
### HARDMAX

- High yield strength and good compromise strength-toughness



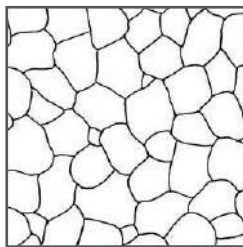
- Bainite-Martensite

## Trials at different heating temperatures and cooling rates

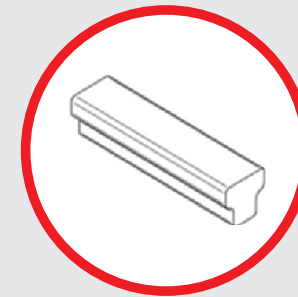
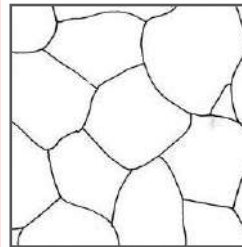


HEATING TEMPERATURE

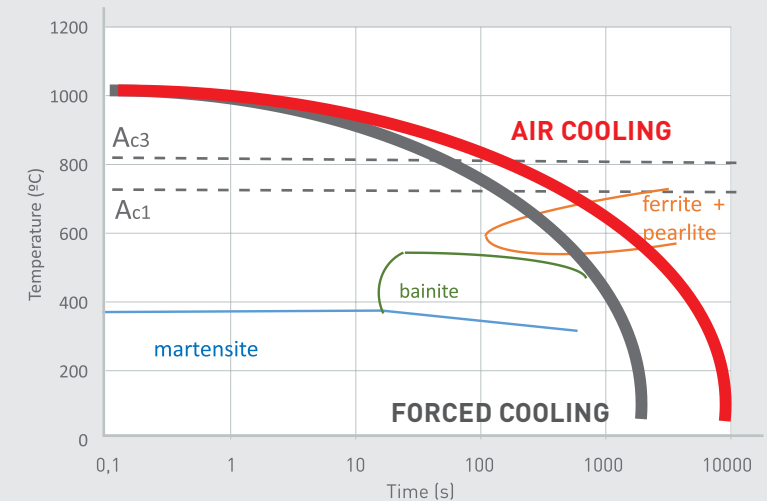
1150°C



1250°C

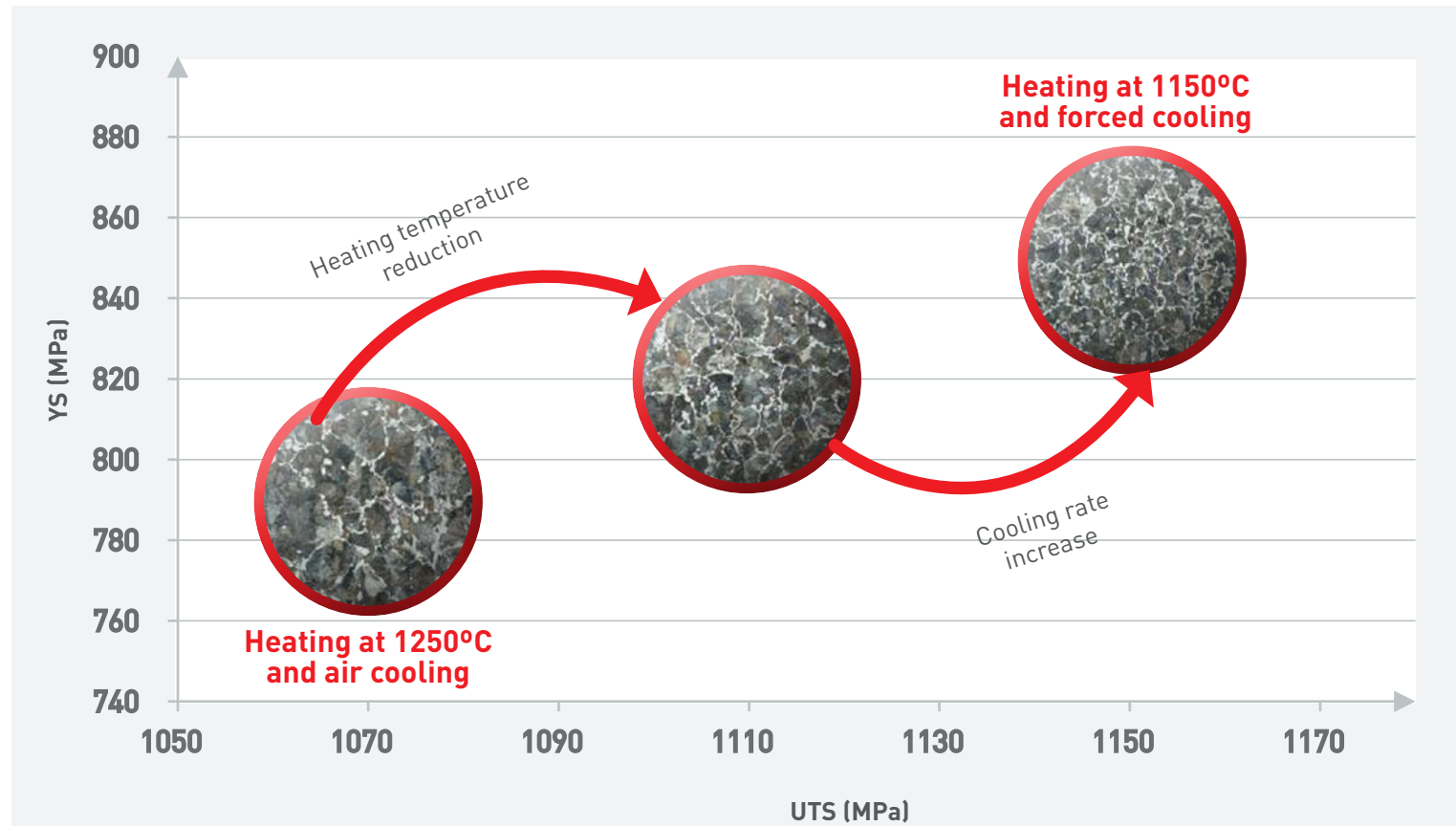


FINAL  
MICROSTRUCTURE:  
FERRITE-PEARLITE



## Selecting optimum conditions

Different conditions of heating and cooling have been analyzed.

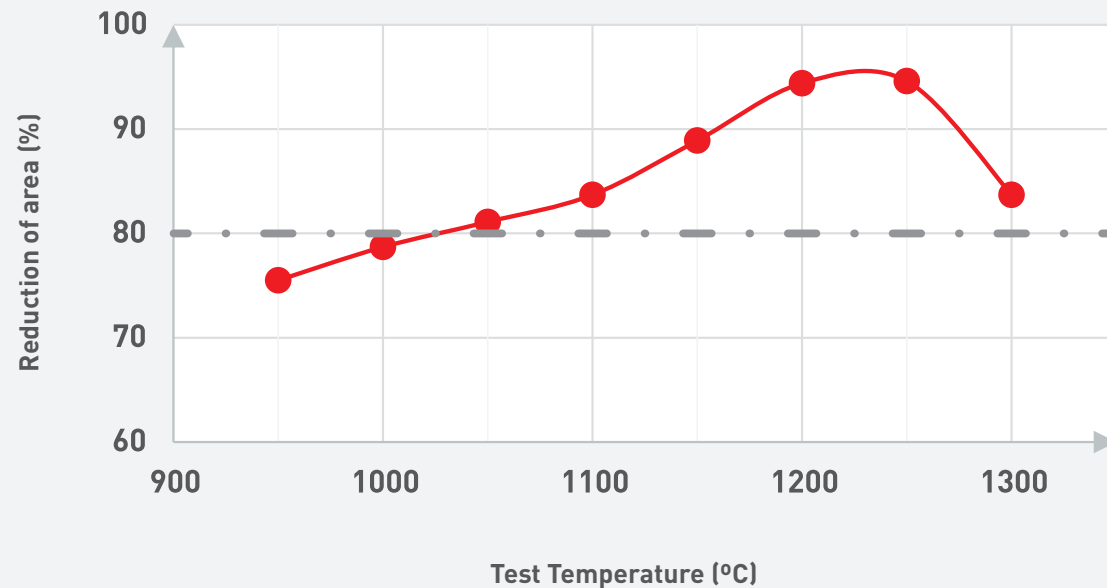


## Thermomechanical Tests

The hot ductility is over 80% at temperatures between 1050 °C and 1300 °C.

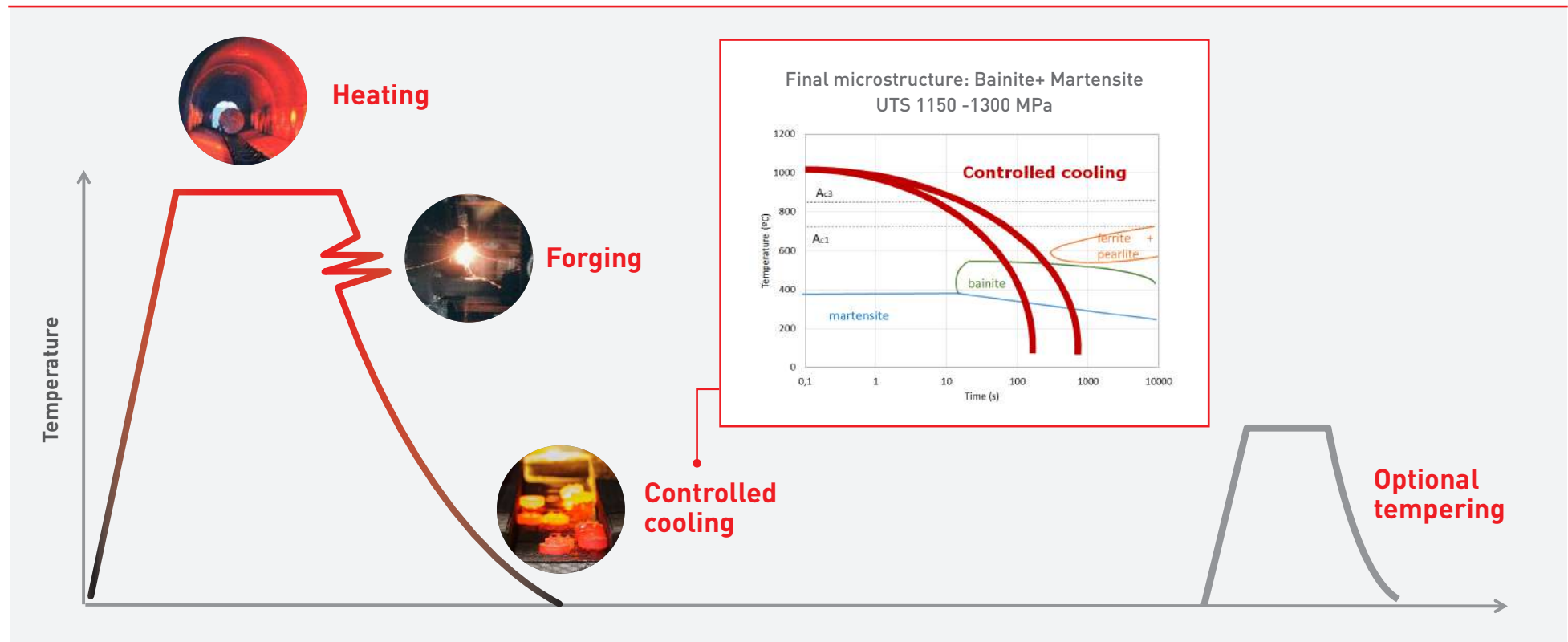


FORGEABILITY: MICRO 1100 HE

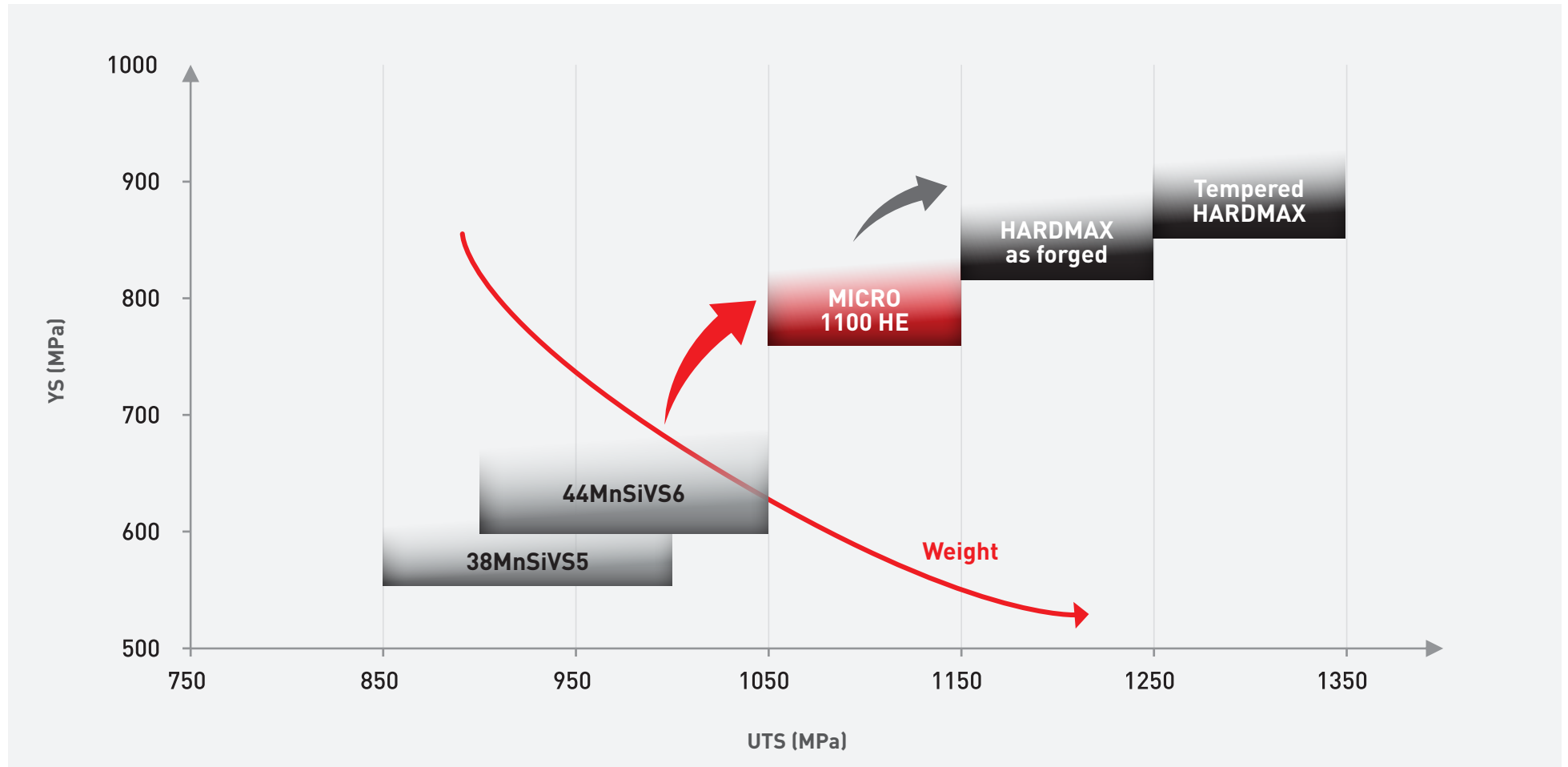


## Tailoring Mechanical Properties

### Manufacturing process



## Comparison MICRO 1100 HE - HARDMAX

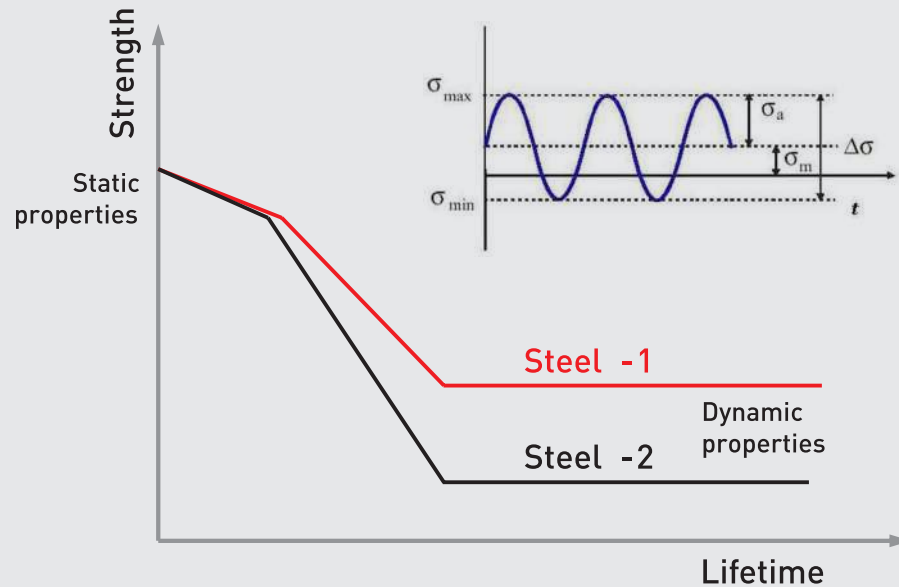
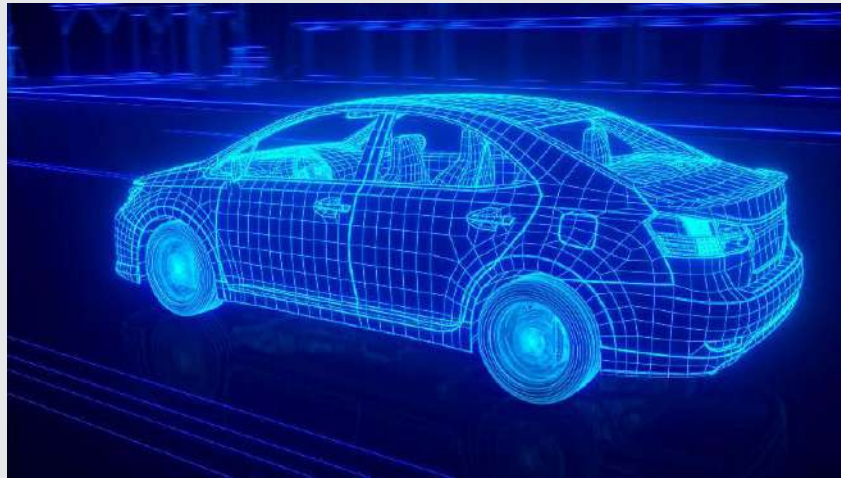




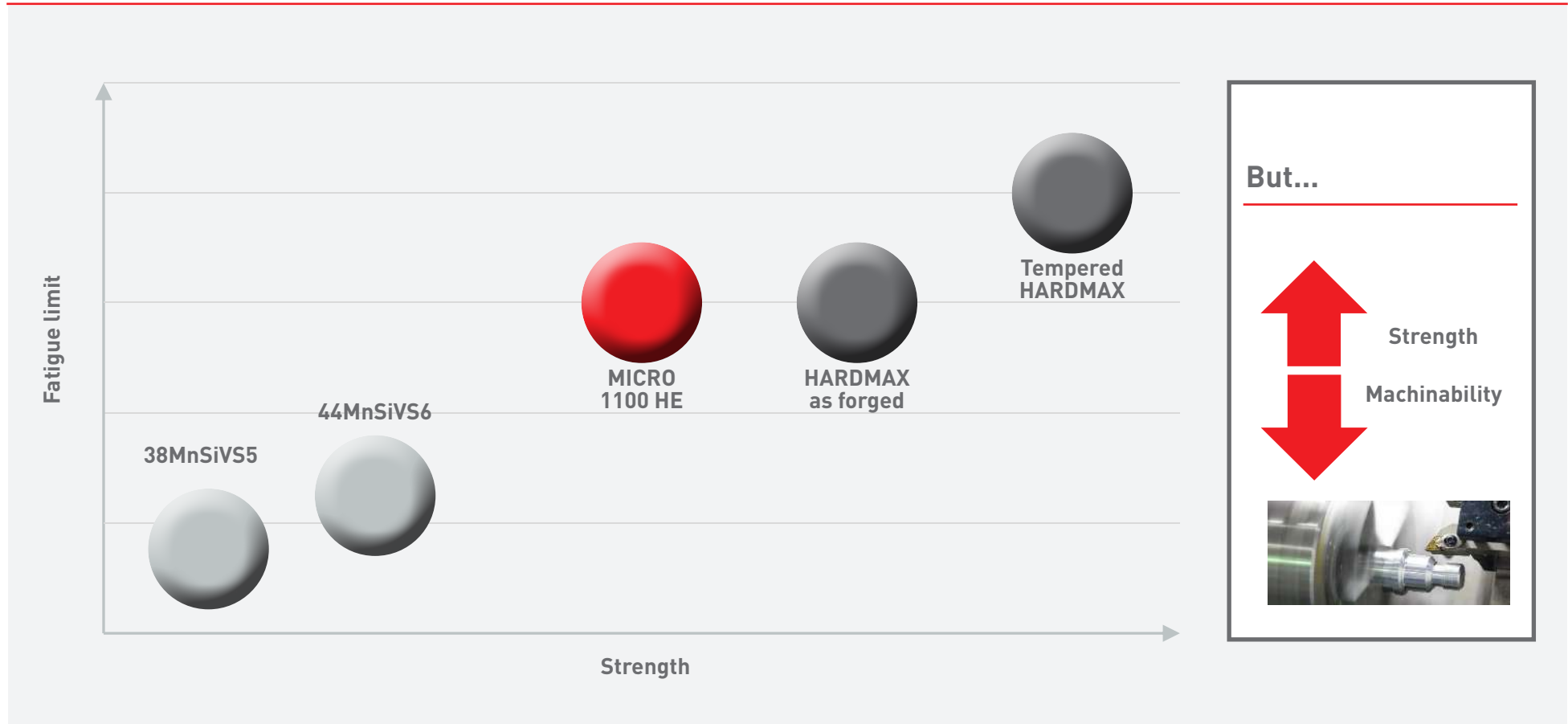
## Is UTS the only critical factor?



- A vehicle is a dynamic system with variable loading.
- Forged components mainly must cope with dynamic loads.
- Fatigue performance is, as least, as important as tensile strength as design factor.

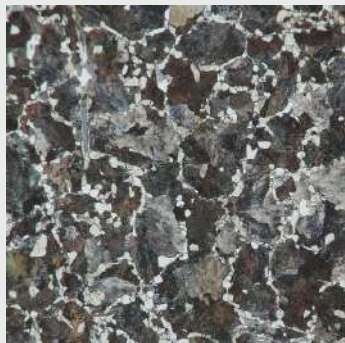


Higher strength, higher fatigue limit: Same ratio?



**MICRO 1100 HE**

- High tensile strength ( $>1050$  MPa)
- Excellent fatigue performance
- Homogeneous Ferrite-Pearlite microstructure
- Good machinability
- Applicable to hot forged parts:
  - Forged components of high mechanical requirements and good response to machining

**HARDMAX**

- High tensile strength ( $\sim 1250$  MPa)
- Excellent fatigue performance
- Mainly Bainitic microstructure
- Applicable to hot forged parts:
  - Forged components with higher mechanical requirements than microalloying steels



- **SIDENOR** has a strong R&D capability in developing new products for automotive market.
- **MICRO 1100 HE** & **HARDMAX** are two lightweighting solutions offered by SIDENOR.



### MICRO 1100 HE

For MICRO 1100 HE, the forger can modify final mechanical properties of components, selecting **forging temperature** and **cooling rate**.



### HARDMAX

HARDMAX is the **bainitic solution** for components with high mechanical requirements. An additional tempering allows to adjust the required properties.

- **Fatigue is a design criterion** for automotive components and its relationship with tensile strength is not always linear.
- SIDENOR continues working to offer the customers a wide range of products for their current and future demands.

Thank you very much



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