

1<sup>st</sup> International Conference on Hot Stamping of UHSS,  
Aug. 21-24, 2014 Chongqing, China

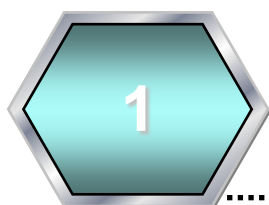


R&D WISCO

**The effect of heating process on strength and the  
original austenite grain size  
of hot forming parts**

2014-08-22

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# The First Part

## Foreword

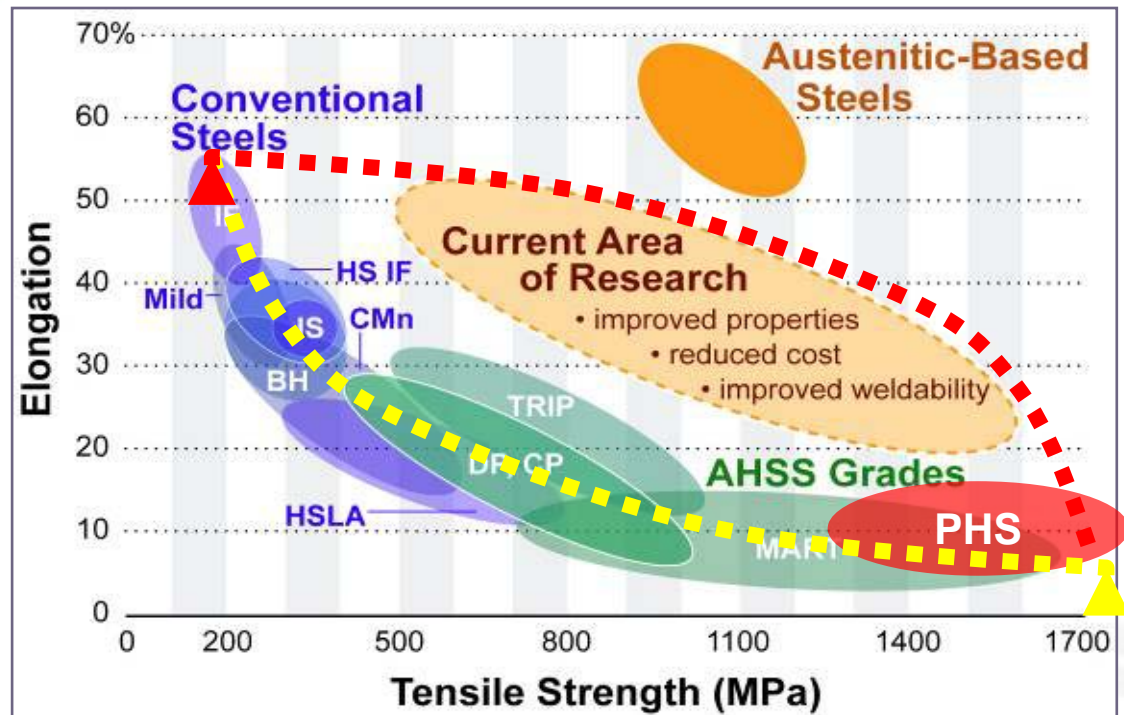


## Auto Body light weight

- ◆ Reduce energy consumption and emissions.
- ◆ But the auto safety must be assured.



How do we ensure the safety of the car ?

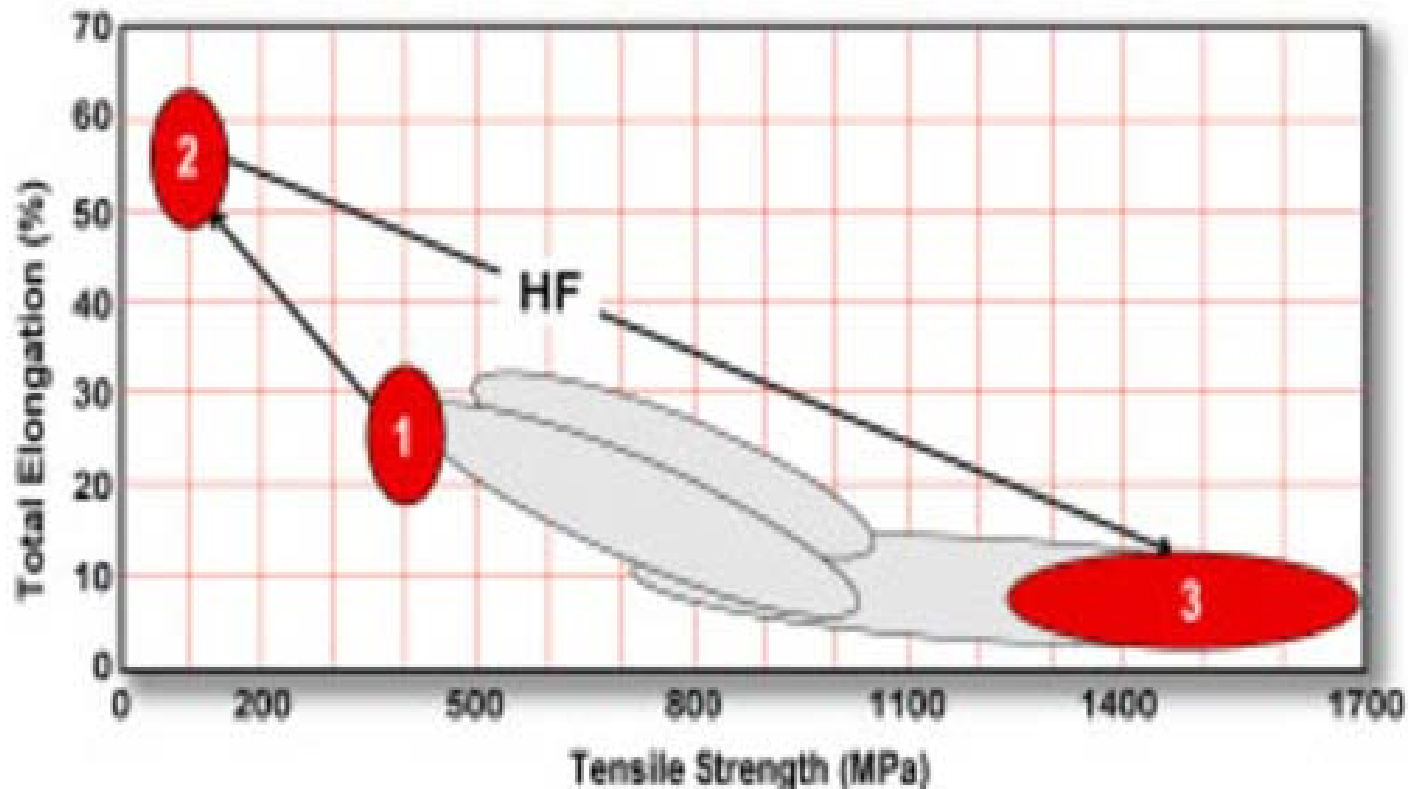


- ◆ Improve the strength of the body materials.
- ◆ The ultra-high strength steels are used widely.

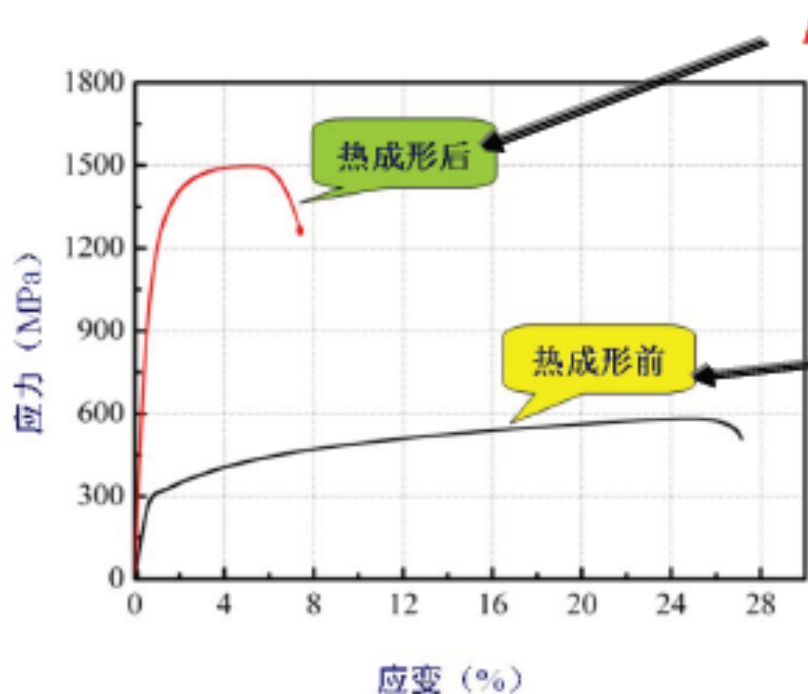
However, with the continuous increasing of strength, formability is getting worse, so the hot formed steel arises at the historic moment.

## Microstructure evolution of hot stamping process.

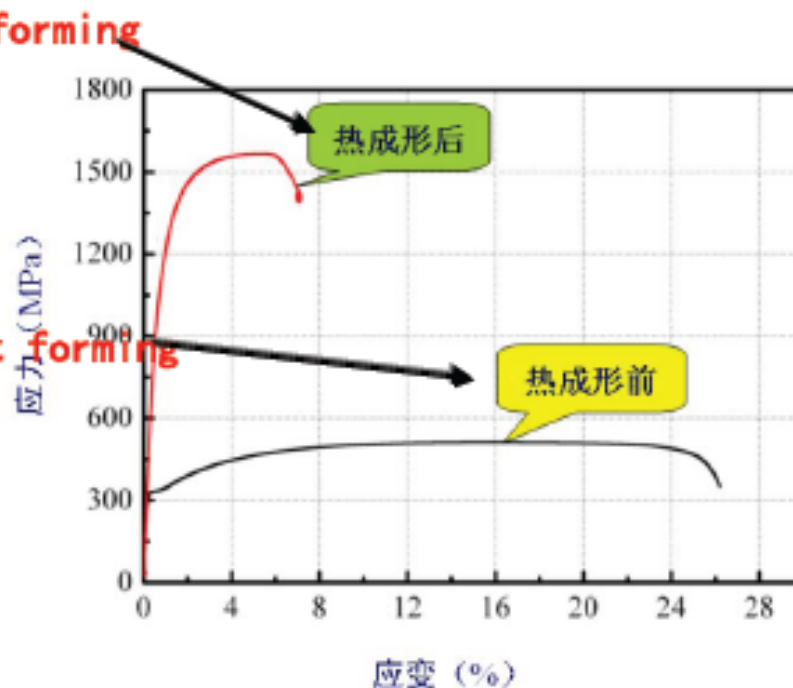
Martensitic transformation leads to the crystallographic transformation of face centered cubic (FCC) austenite into body centered cubic (BCC) martensite.



Before and after hot stamping stress and strain curve.



WHT1300HF



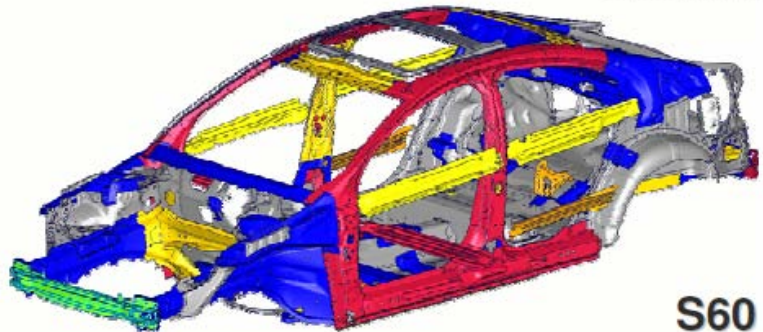
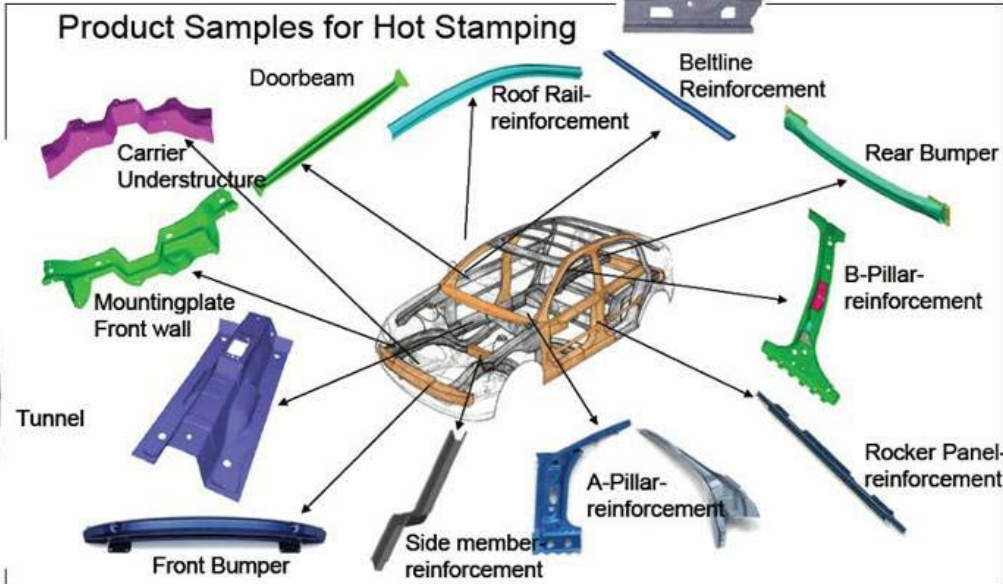
WHT1500HF

We have been successfully developed and produced WHT1300HF and WHT1500HF grade hot formed steel since 2009.

# Foreword

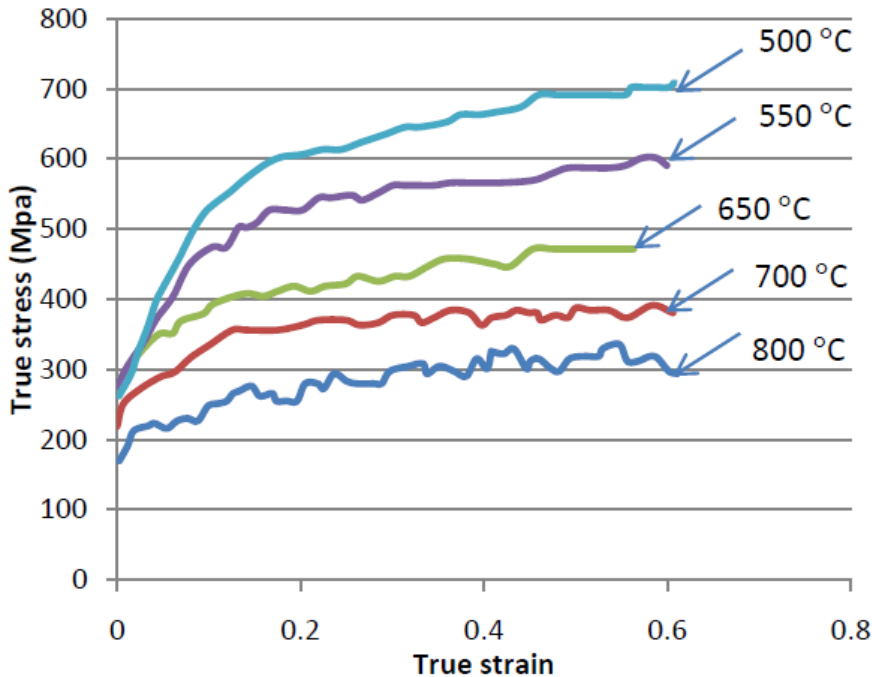
Hot formed steel

- ◆ Good formability
- ◆ No springback
- ◆ Low forming load
- ◆ Low wearing of die
- ◆ High dimensions accuracy





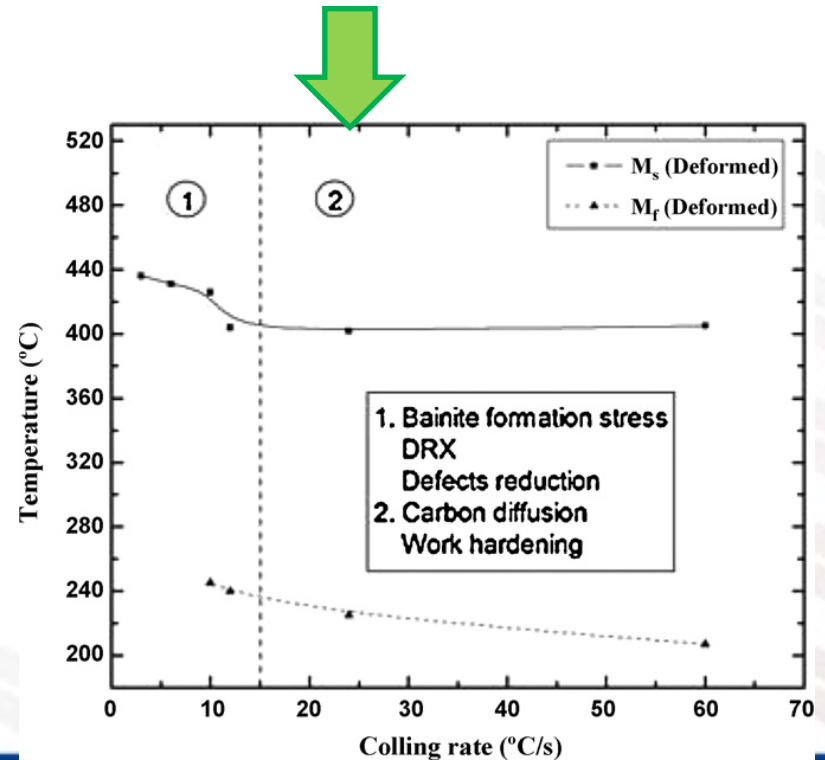
# Foreword



The main objective of the present research is focused on the effect of heating process on strength and the original austenite grain size of hot forming parts.

## Recent research on the hot formed steel.

- ◆ Have many research results about:
- ◆ The effect of hot plastic deformation
- ◆ Cooling rate on  $M_s$  start temperatures
- ◆ High temperature flow stress character
- ◆ Hot stamping process simulation etc.





# The Second Part

## Experiment Material and Methods

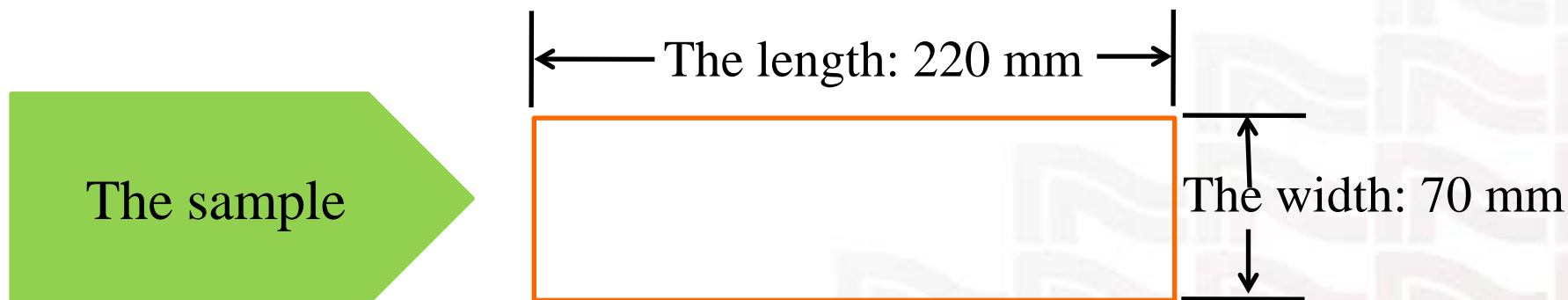


## Experiment Material and Methods

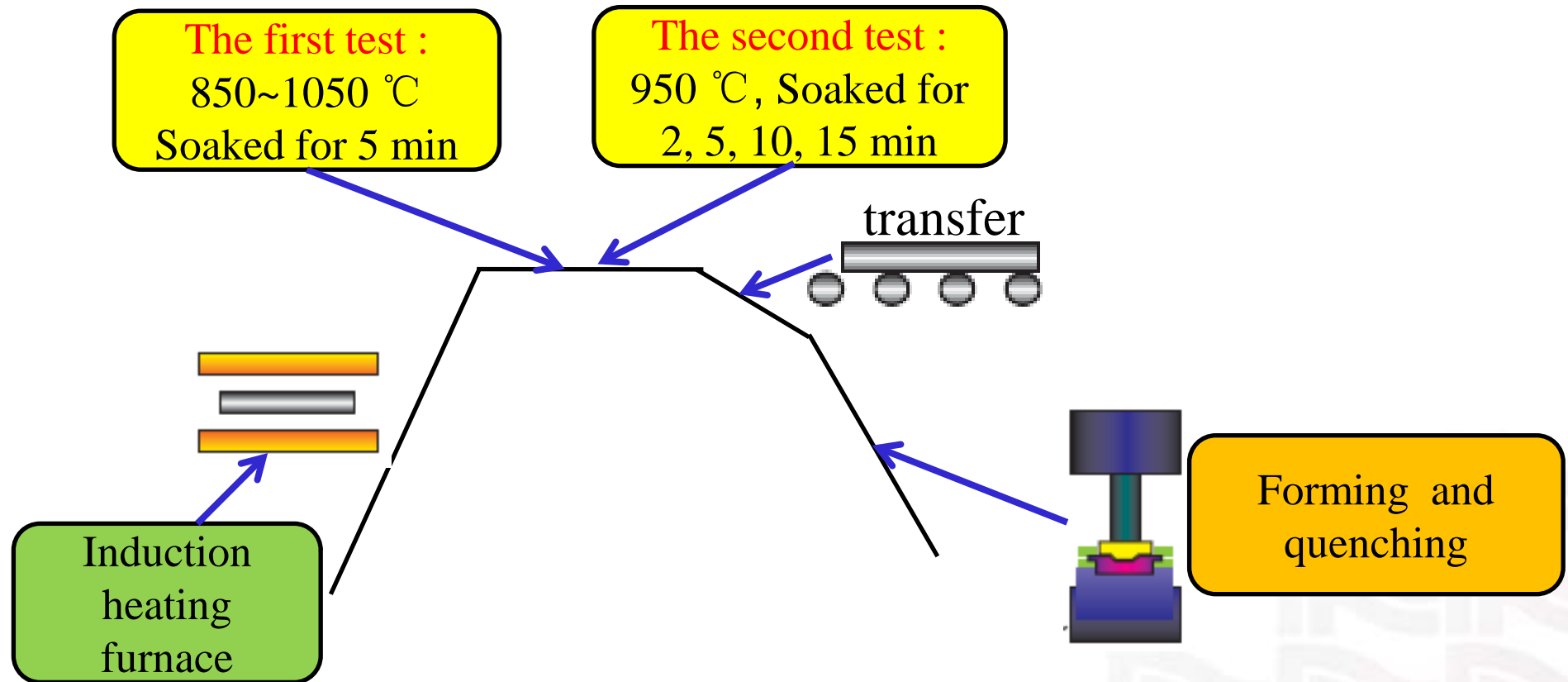
The steel sheet used for this work is WHT1300HF hot stamping steel which is produced by Wuhan Iron and Steel Group Corp. (WISCO) and has a nominal thickness of 1.5 mm.

### Chemical composition (wt%)

C	Si	Mn	P	S	Al	B
0.20	0.24	1.15	0.008	0.005	0.030	0.002



# Experiment Material and Methods



- ◆ Tensile tests were carried out by the material universal testing machine.
- ◆ The microstructures and original austenite grain size were studied by light microscopy.

## The Third Part

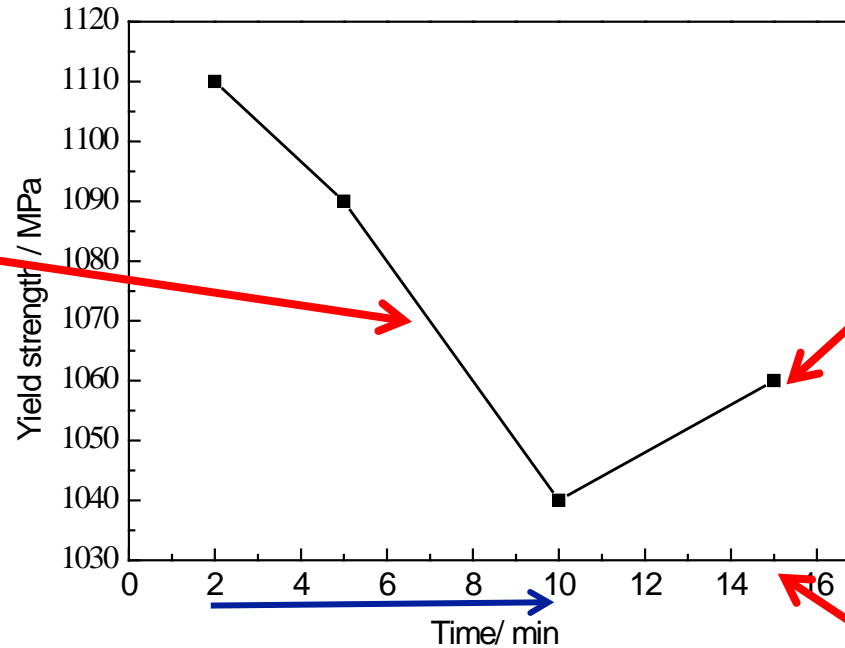
### Results and Discussion



# Results and Discussion

## The relationship between strength and heating time

The yield strength rapidly decreased.



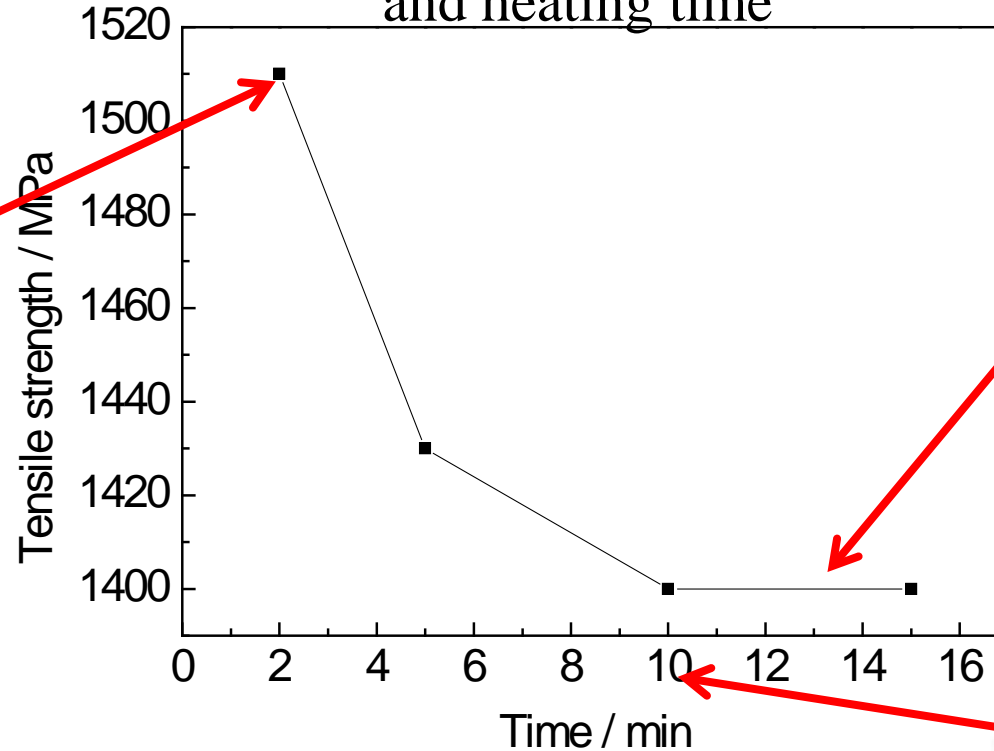
The yield strength slightly increased.

The relationship between yield strength and heating time

When the holding time was extended to 15 minutes.

## Results and Discussion

the relationship between tensile strength  
and heating time



The tensile strength reach the highest values with the holding time of 2 min.

The tensile strength can be controlled stability at 1400MPa.

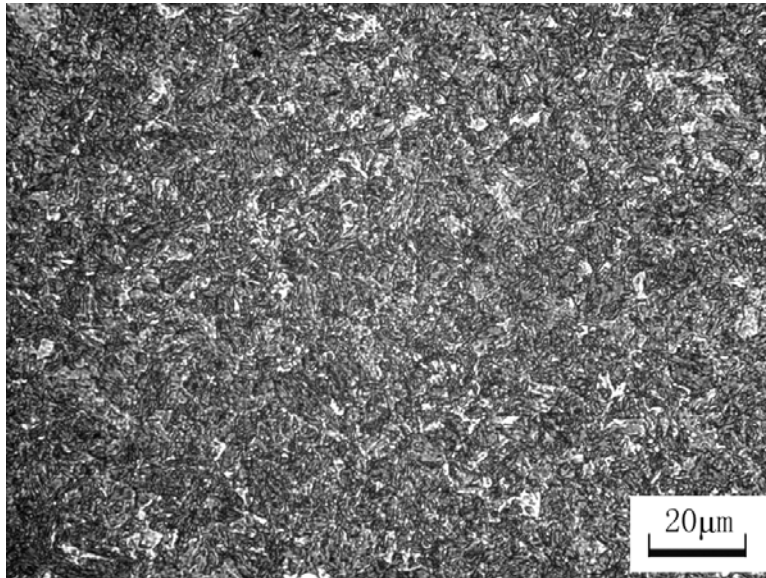
when the holding time is 10 minutes or more.

When it is heated to 950°C and held time from 2 min to 15 min. The tensile strength can be stable at 1400 MPa or more. Avoid the strength not be assured due to the change of heating time

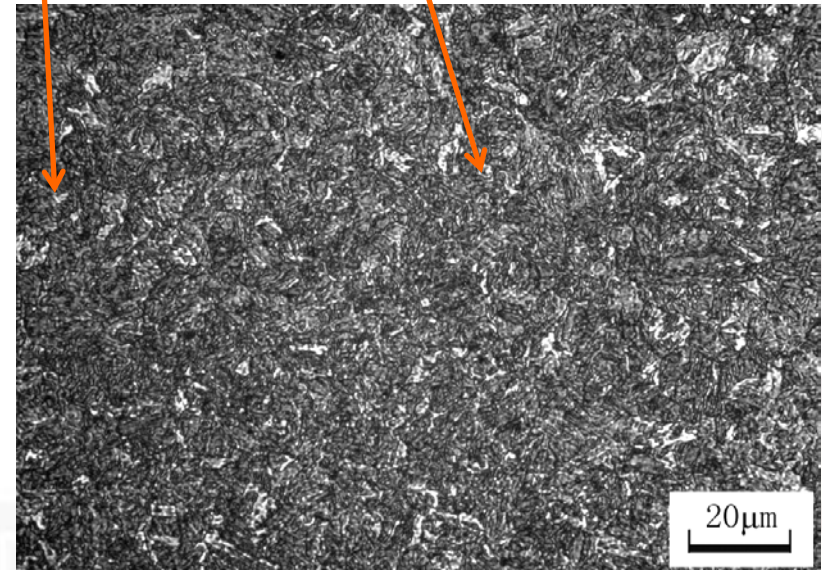
## Results and Discussion

### The relationship between the microstructure and heating temperature.

#### Lath martensite

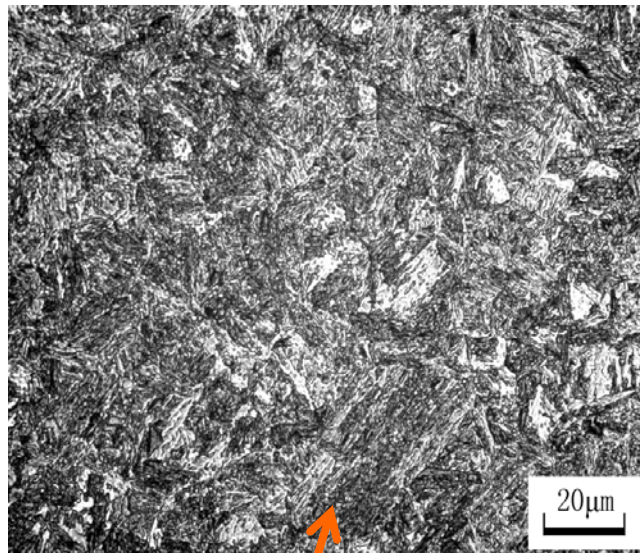


The black and white blocks within each M packet. Which are the same orientation packet or block.



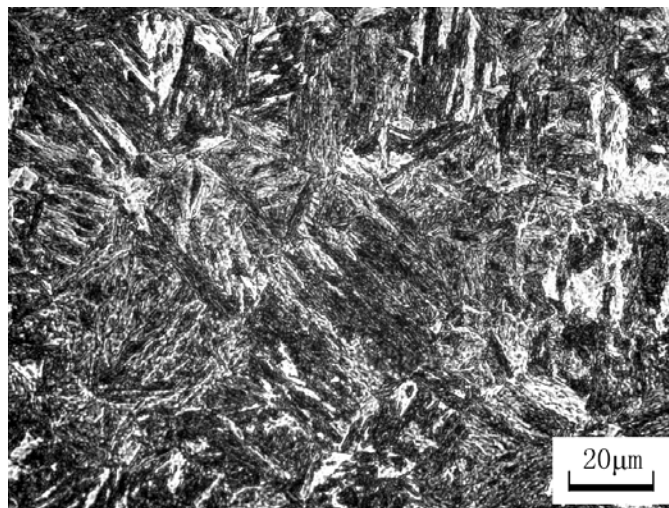
- ◆ The martensite lath is short.
- ◆ Packets are small.

## Results and Discussion



The martensite lath packets grows and lath increases obviously.

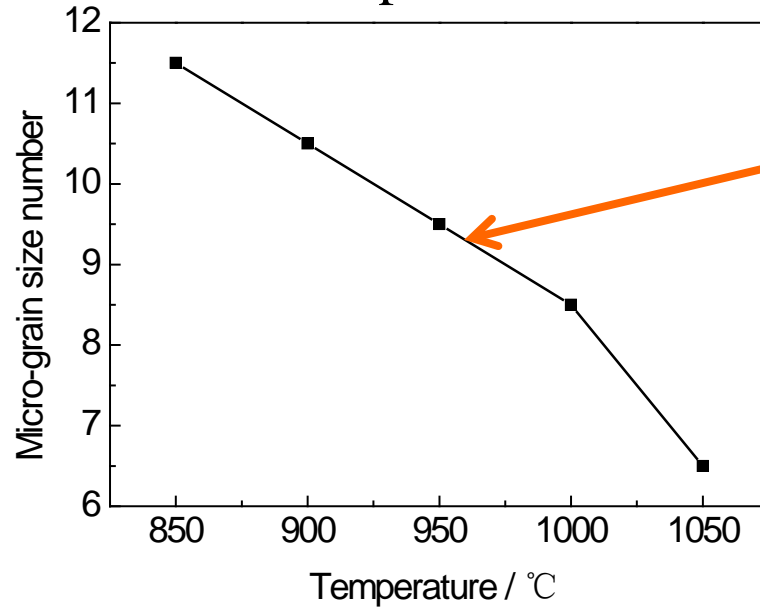




- ◆ The lath length of martensite even increased to 32~35 microns.
- ◆ The lath packet is maximum.

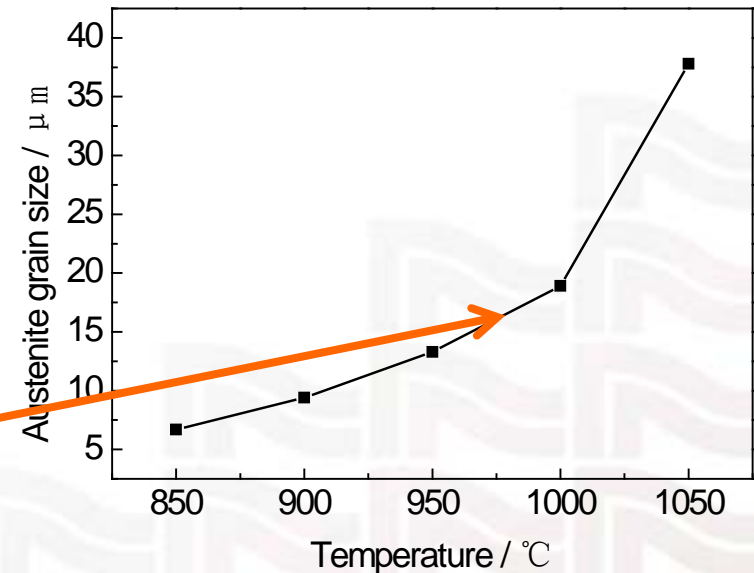
# Results and Discussion

Relationship between micro-grain size numbers and heating temperature



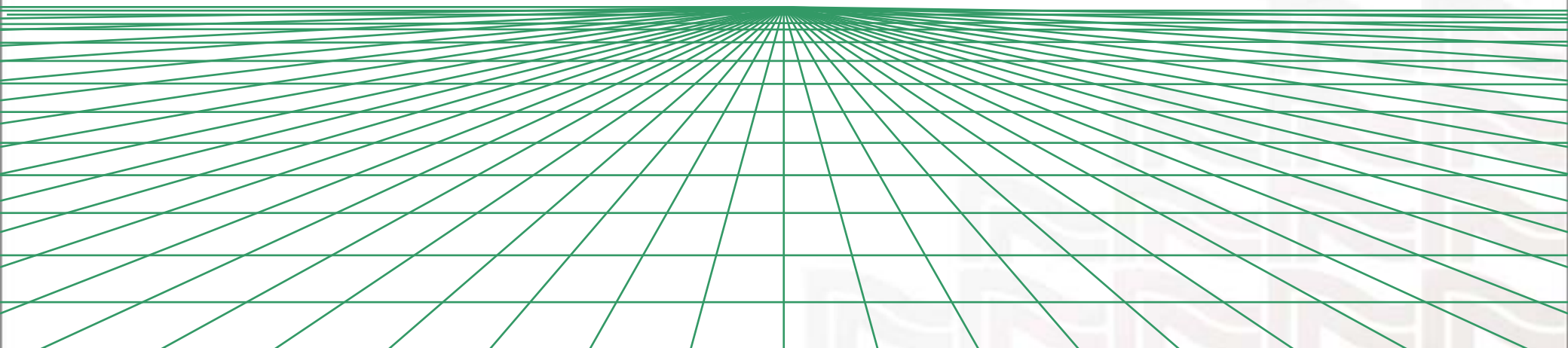
the original austenite grain size of the sample decreased.

the original austenite grain grew up.



## The Fourth Part

### Conclusions



## Conclusions

(1) After heated to 950 °C and soaked for 2, 5, 10 and 15 min respectively was quenched by die:

◆The yield strength of the hot forming steel WHT1300HF presented earlier decrease and later increase trend with the extension of holding time.

◆While the tensile strength was first reduced and then maintained at more than 1400 MPa.

◆So it avoided the strength of the hot stamping parts declined due to the change of heating time.

(2) When it was heated from 850 °C to 1050 °C and soaked for 5 min respectively, and subsequently quenched by die.

◆The microstructure of the test steels were lath martensite, but the lath martensite size and the packet width was slightly different.

◆The martensite lath length and packet width were maximum when the temperature was rose to 1050 °C.

(3) The influence of the heating temperature on the original austenite grain size is remarkable.

◆The austenitic grains grew up quickly with the increase of heating temperature.

◆When the temperature was rose to 1050 °C, the original austenite grain diameter reached to 37.8 microns.

(4) As a result, the most appropriate heating process is a steel sheet heated to 900 ~ 950 °C and soaked for 3 ~ 5 min.



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