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The Research on Technological Parameters of Short Forming Process of Ring Parts

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2 Theory & Method

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Introduction

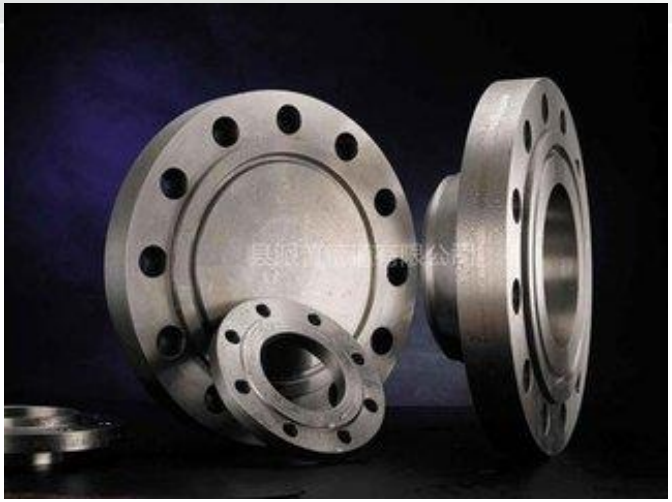


Fig.1 Different Size of Flanges

Introduction


Smelting &Casting

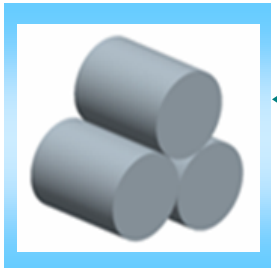

Steel ingot

Heating


Cogging


Round bar stock


Cutting

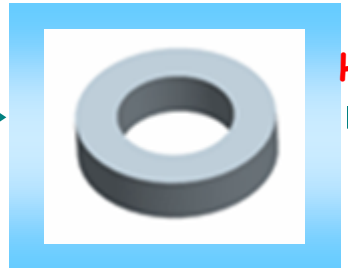

Short bar stock

Heating


Upsetting


Workpiece


Punching


Punching piece

Heating

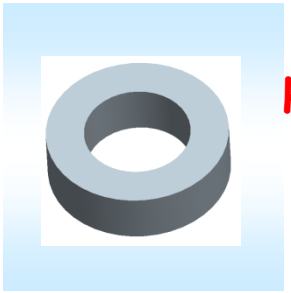

Hot rolling


Formed part

Fig.2 The Traditional Forming Process

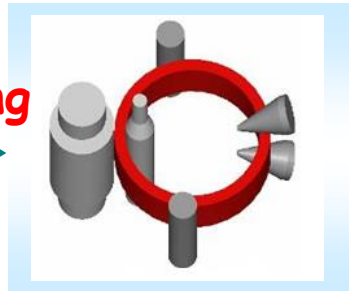
Introduction

Smelting &Casting

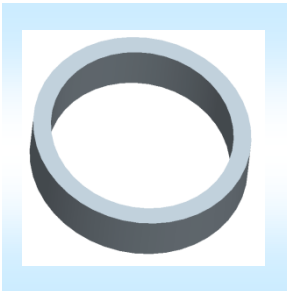


Casting ring blank

Heating



Hot rolling

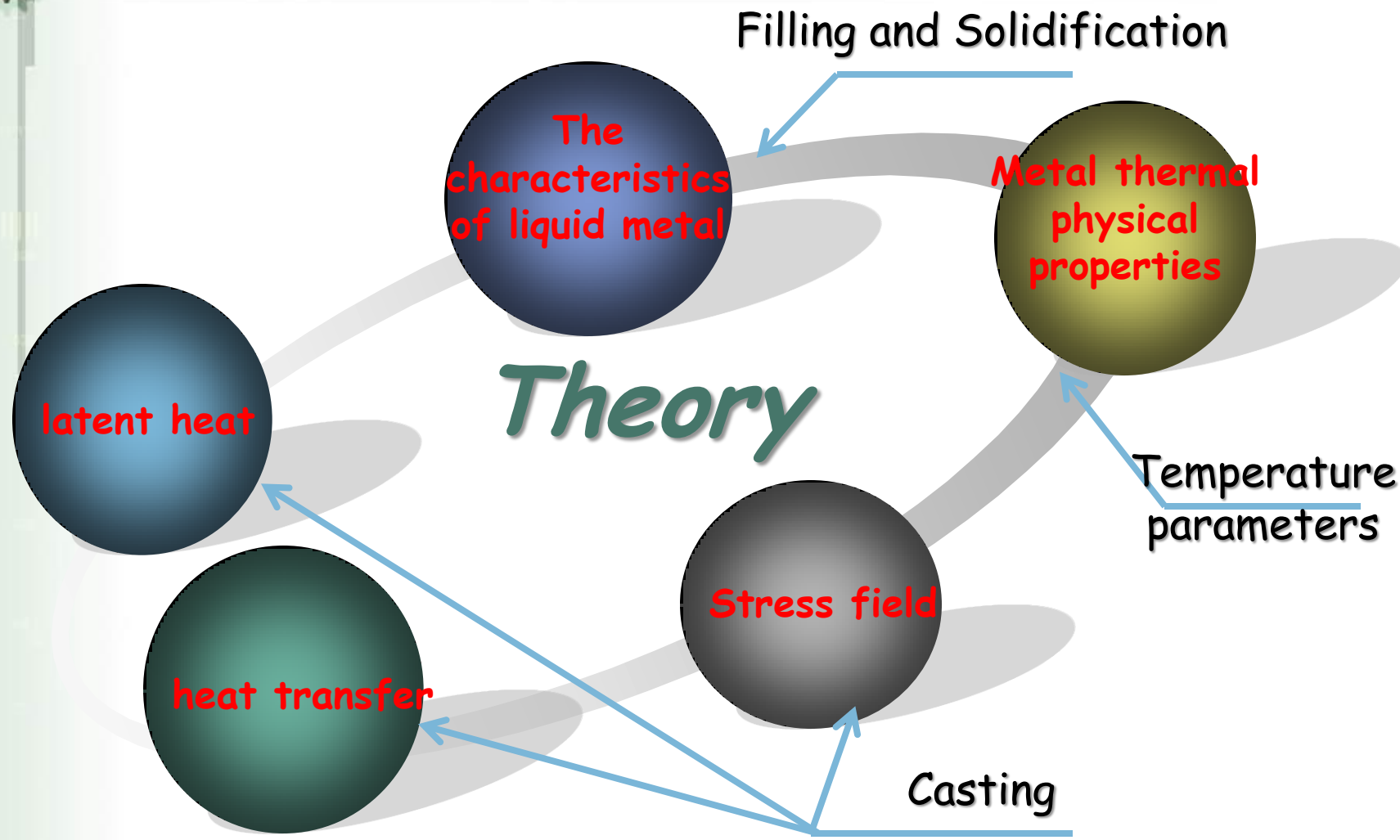


Formed part

Fig.3 Process of Casting-Rolling Continuous Forming

The purpose of research: to obtain main technological parameters of Casting-rolling continuous forming

Theory & Method



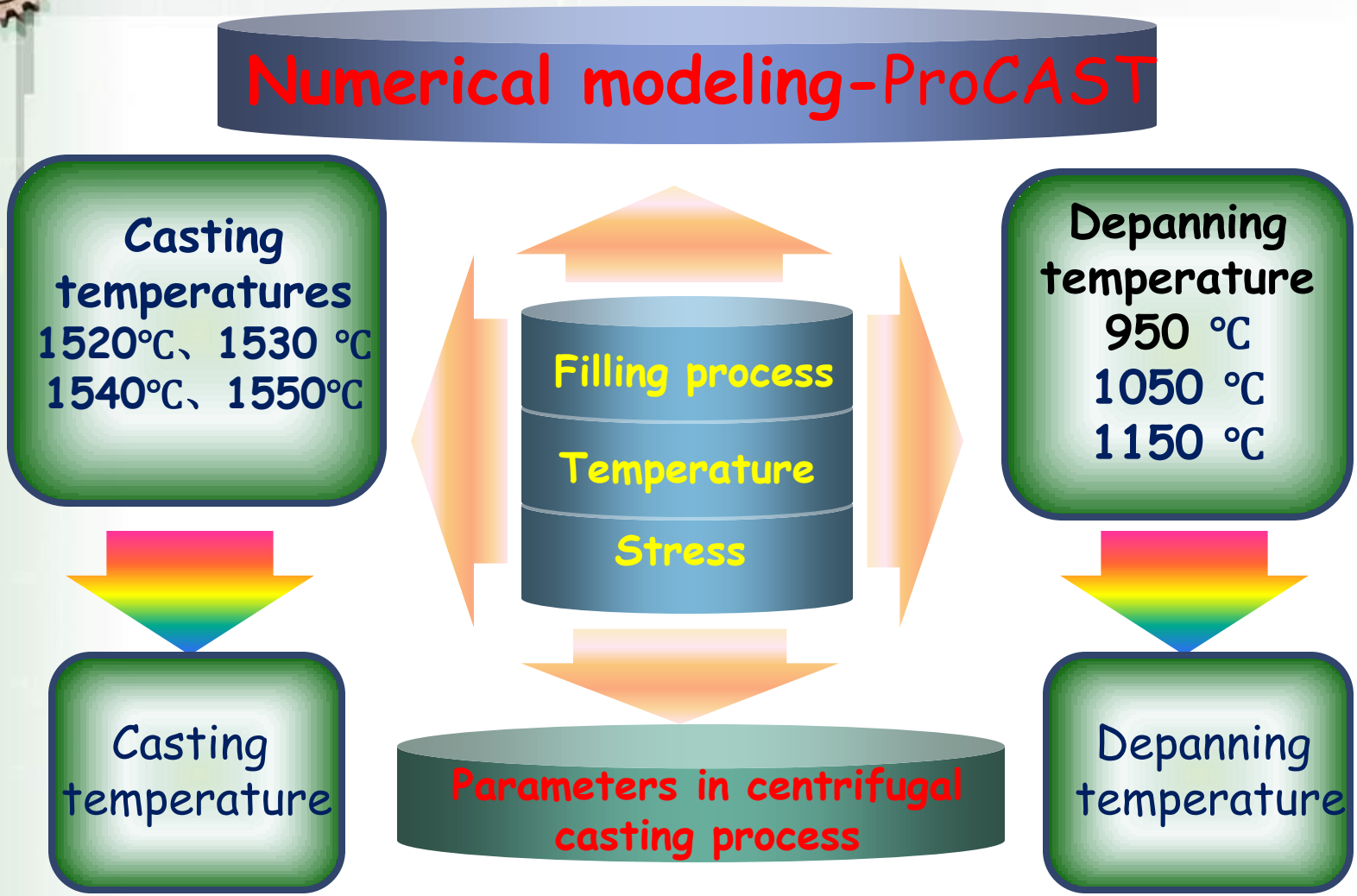
Theory & Method

Theoretical analysis
JMatPro software

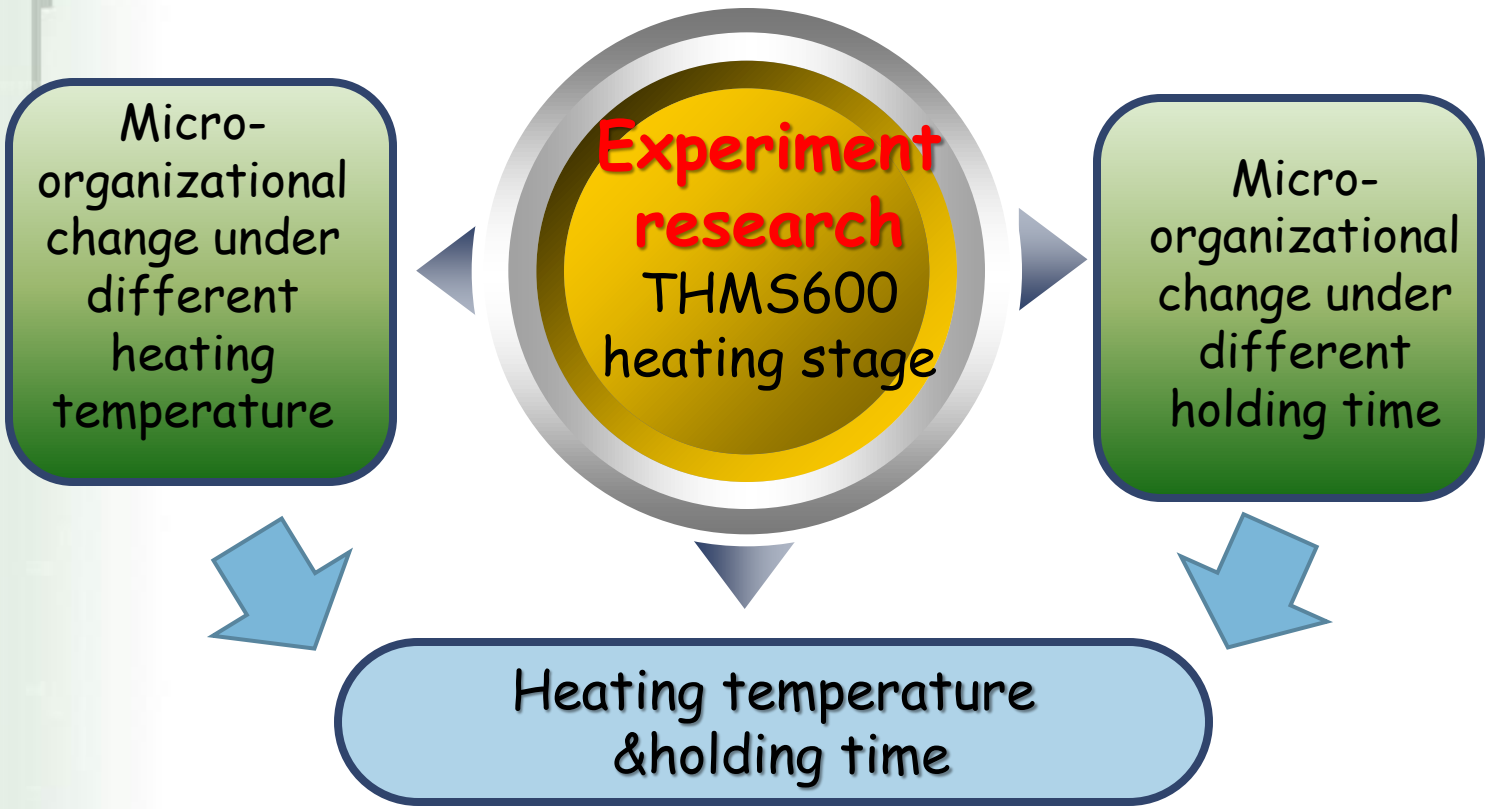
Numerical modeling
ProCAST software/ ABAQUAS software

Experiment research
THMS600 heating stage

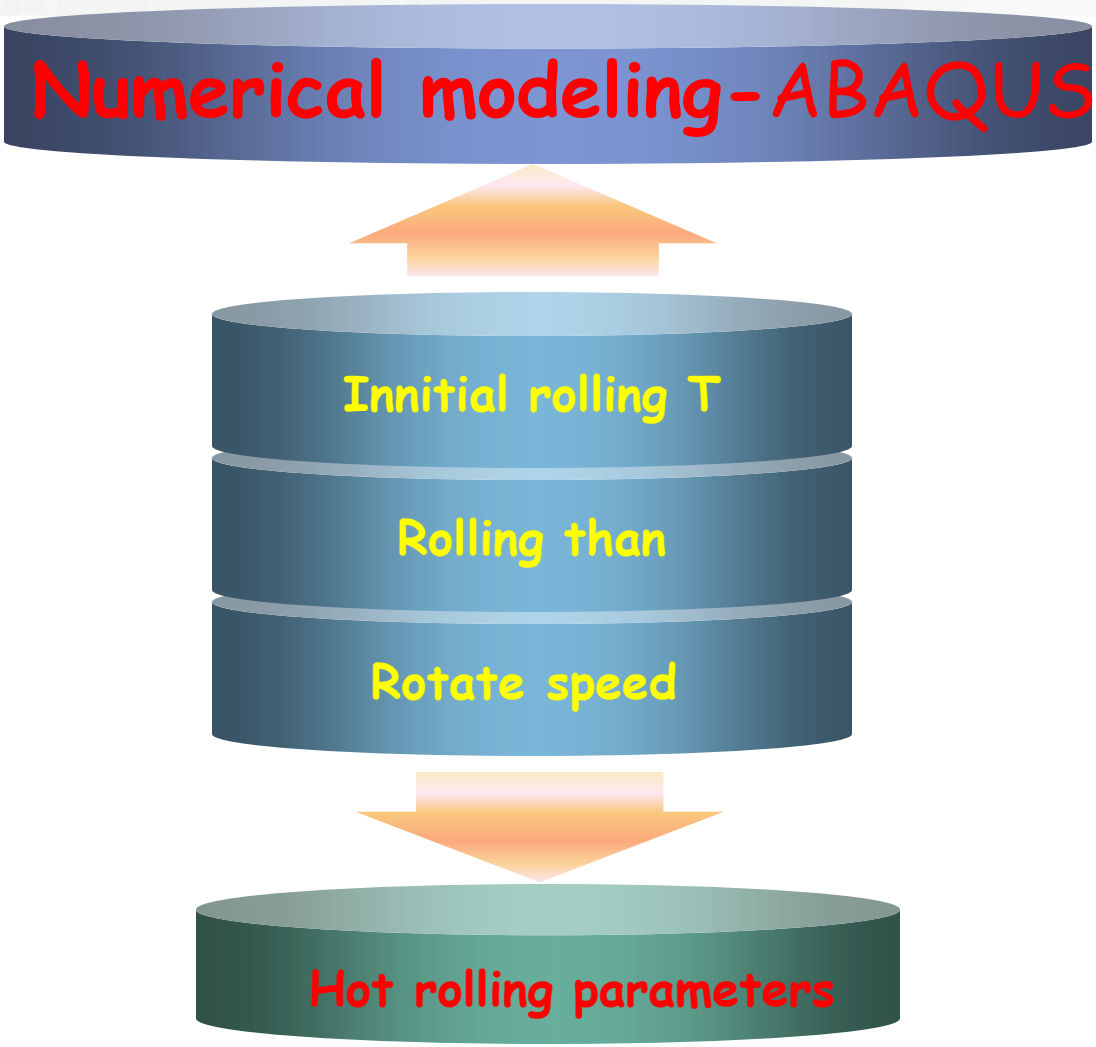
Theory & Method



Theory & Method



Theory & Method



Results & Discussion Ⅰ

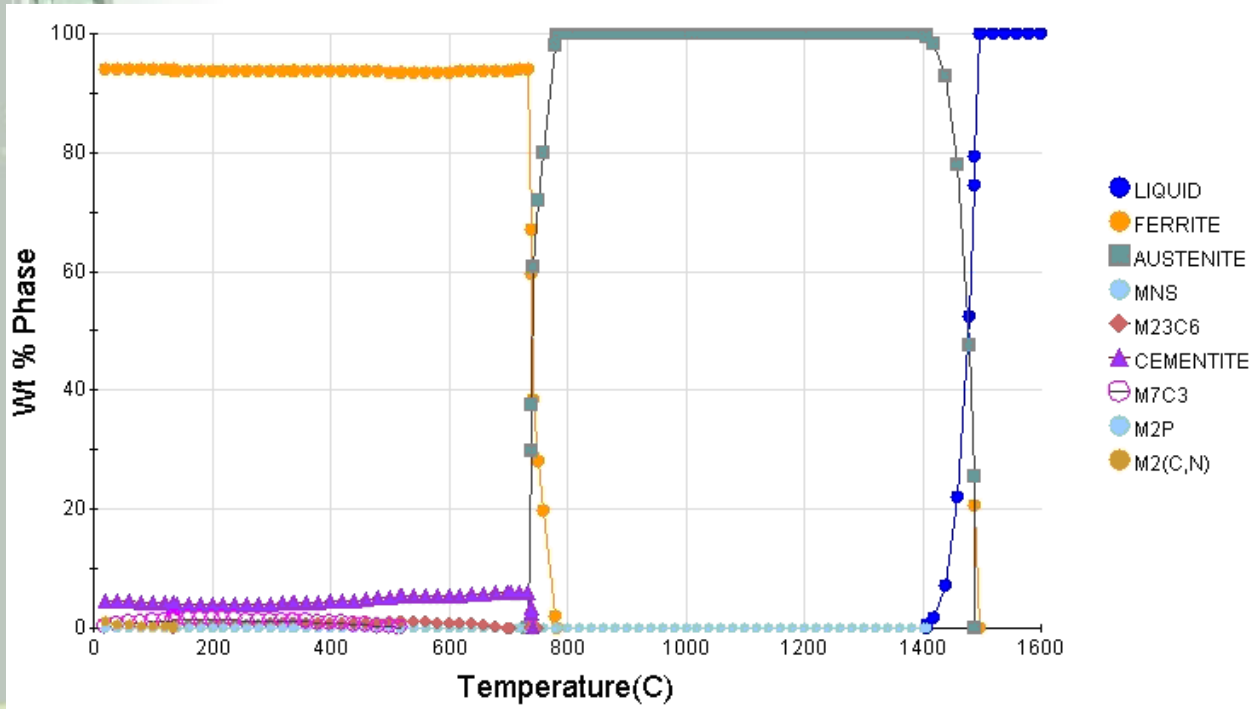
Ⅰ. The research on smelting & casting

ⅰ.The smelting temperature

Table1 Chemical Composition of 42CrMo Steel（wt，%）

Element	C	Si	Mn	S	Cr	Mo	P
42CrMo	0.46	0.28	0.72	0.007	1.13	0.22	0.012

Results & Discussion I



Liquid phase temperature: 1488℃

Solidus temperature: 1413℃

Fig.4 Phase Diagram of 42CrMo As-cast Steel Alloy

The smelting temperature is 1700℃

Results & Discussion I

ii .The casting temperature

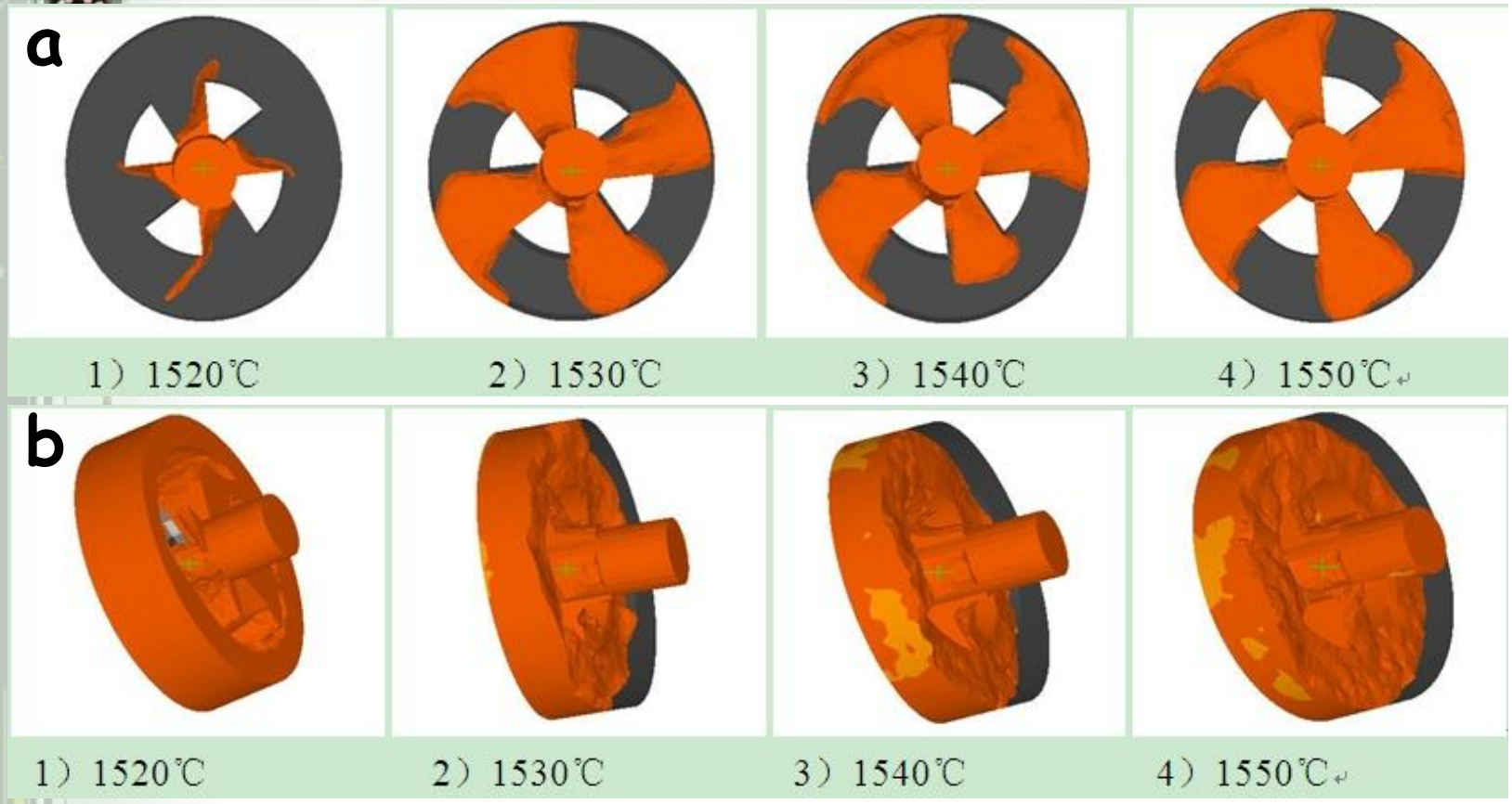


Fig.5 Filling Condition on 7 seconds(a) and 30 seconds(b)

Combined with the practical capacity and the filling condition, the best casting temperature is 1520℃.

Results & Discussion I

iii. The rotational speed of casting mold

$$n = 29.9\sqrt{\frac{G}{R}} \qquad (1)$$

n—— rotational speed of casting mold (r/min)

R——inside radius of mold(m)

G——gravity coefficient

For Φ864mm×Φ530mm×234mm n=480r/min

Results & Discussion I

iv .The molding temperature

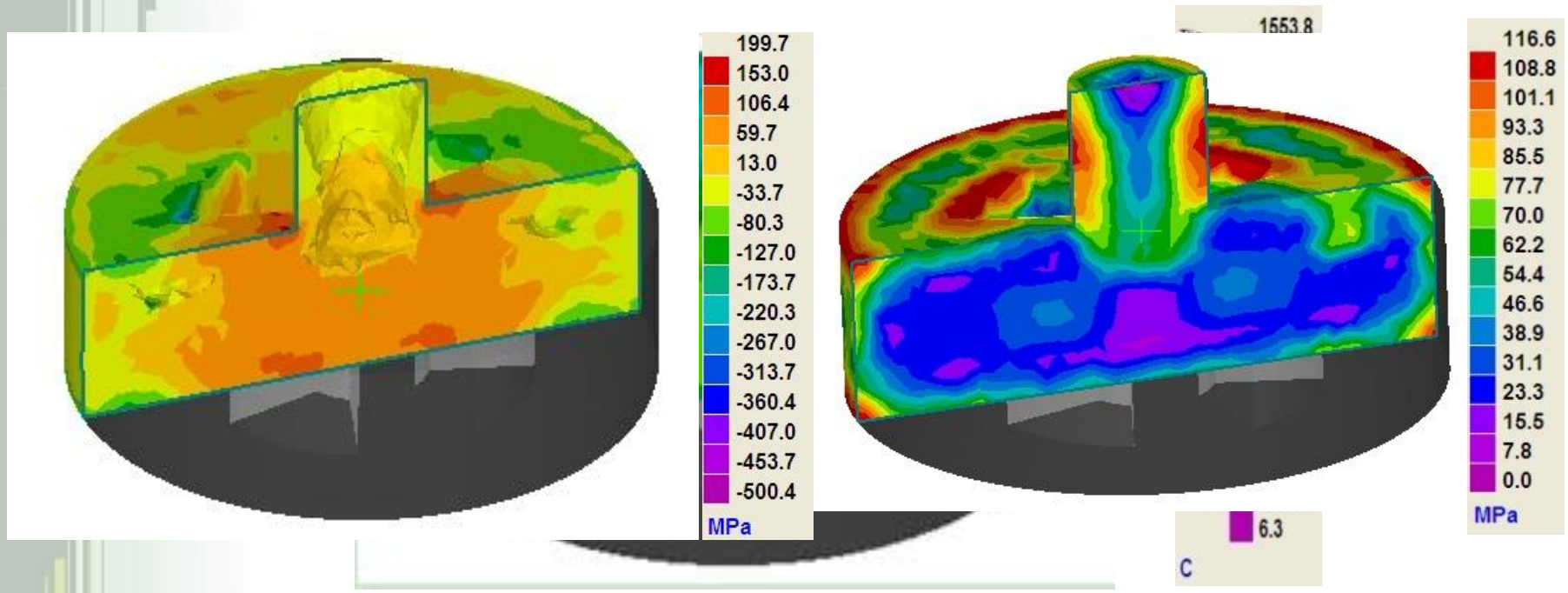


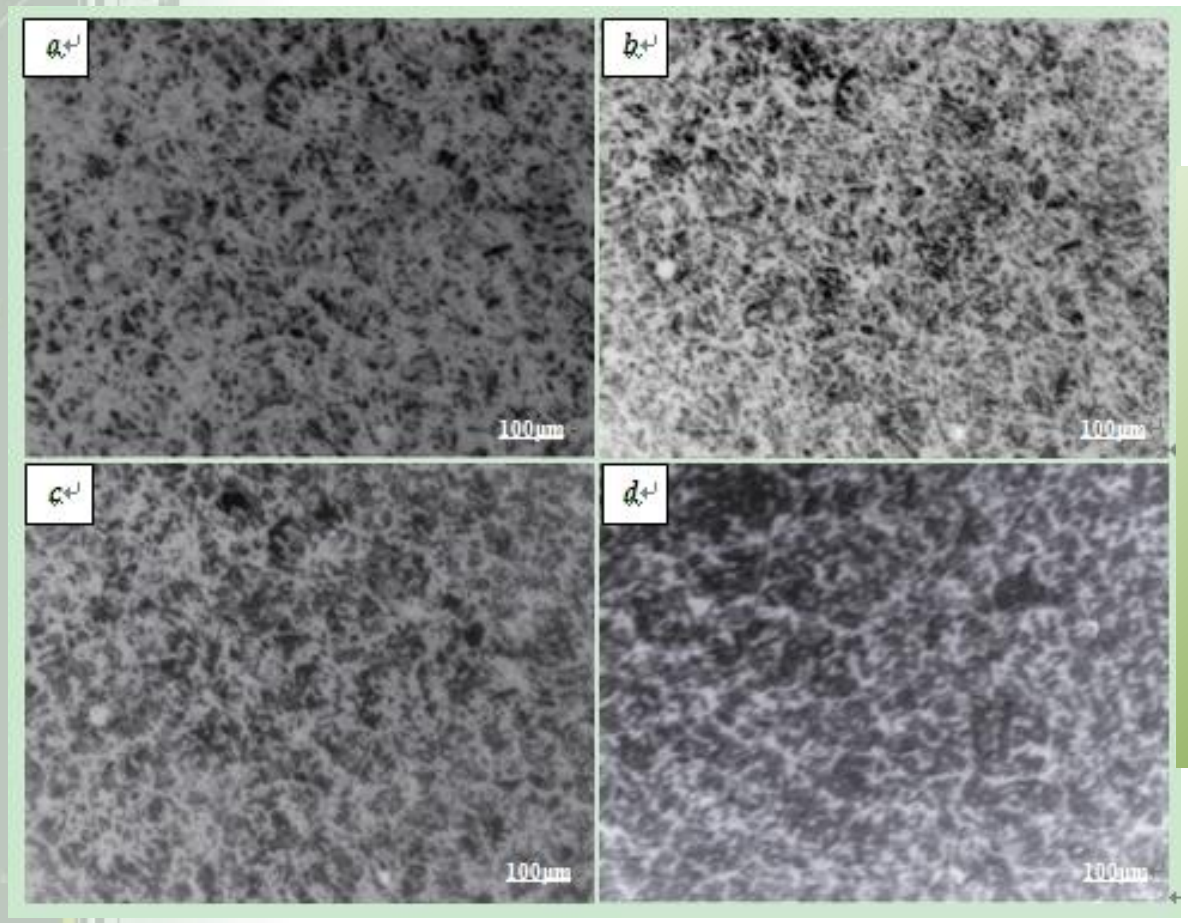
Fig.7 The stress cloud charts before molding at 1050℃

The stress cloud charts after molding at 1050℃

Results & Discussion Ⅱ

Ⅱ. The parameters on heat preservation process

i .The heating temperature

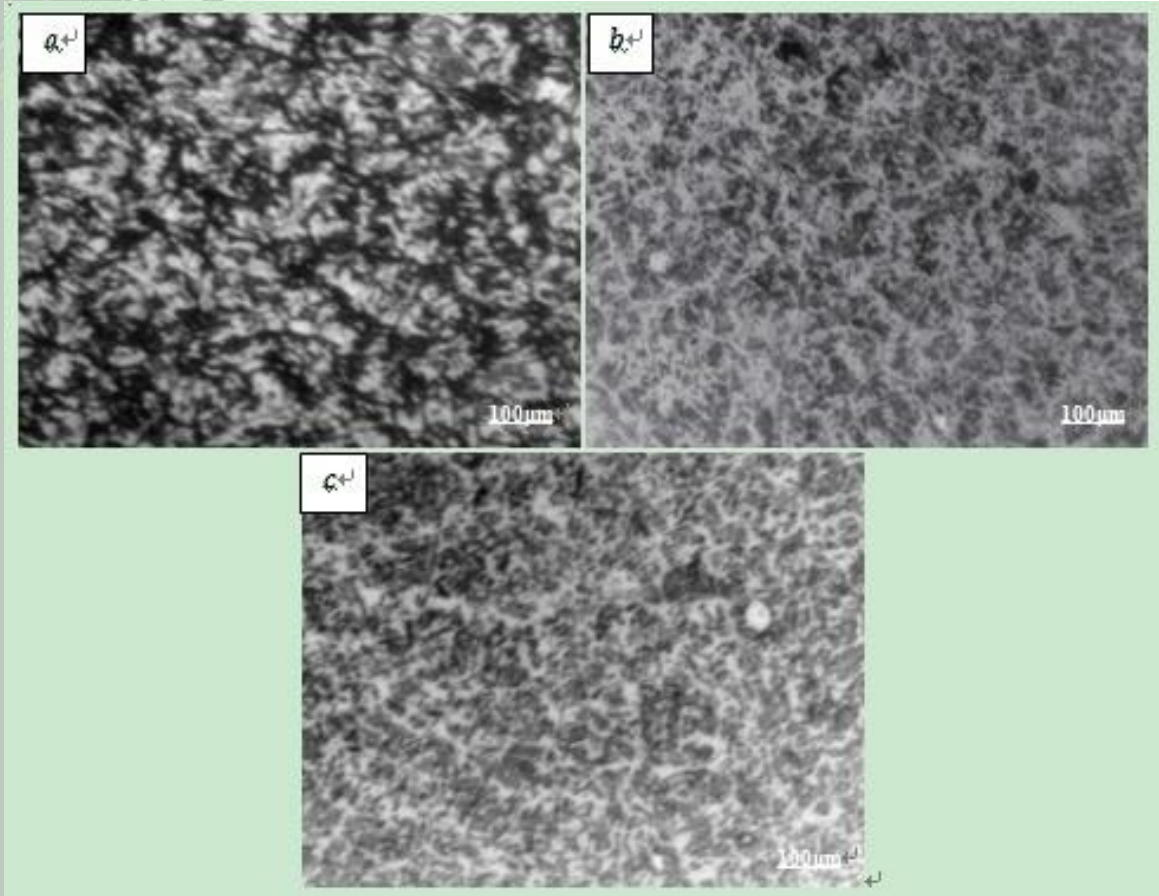


The microstructure under 1050℃ shows small and homogeneous structure in grains .The casting with this structure will have high strength and excellent comprehensive mechanics performance.

Fig.8 Micro-organizational change under different heating temperature (hold10min)(×500)a）850℃、b）950℃、c）1050℃、d）1200℃

Results & Discussion Ⅱ

ii .The holding time



The microstructure under10min (b) shows the most uniformed grain size in evidence. When keeping for 15min, the size of grains has grown large and the edge of the grains has changed fuzzy. As a result, the best holding time is 10min, the grain size meets the requirements of hot-rolling.

Fig.9 Micro-organizational change under different holding time(×500)

***a*）5min、*b*）10min 、*c*）15min）**

Results & Discussion Ⅲ

Ⅲ. The parameters on hot rolling process

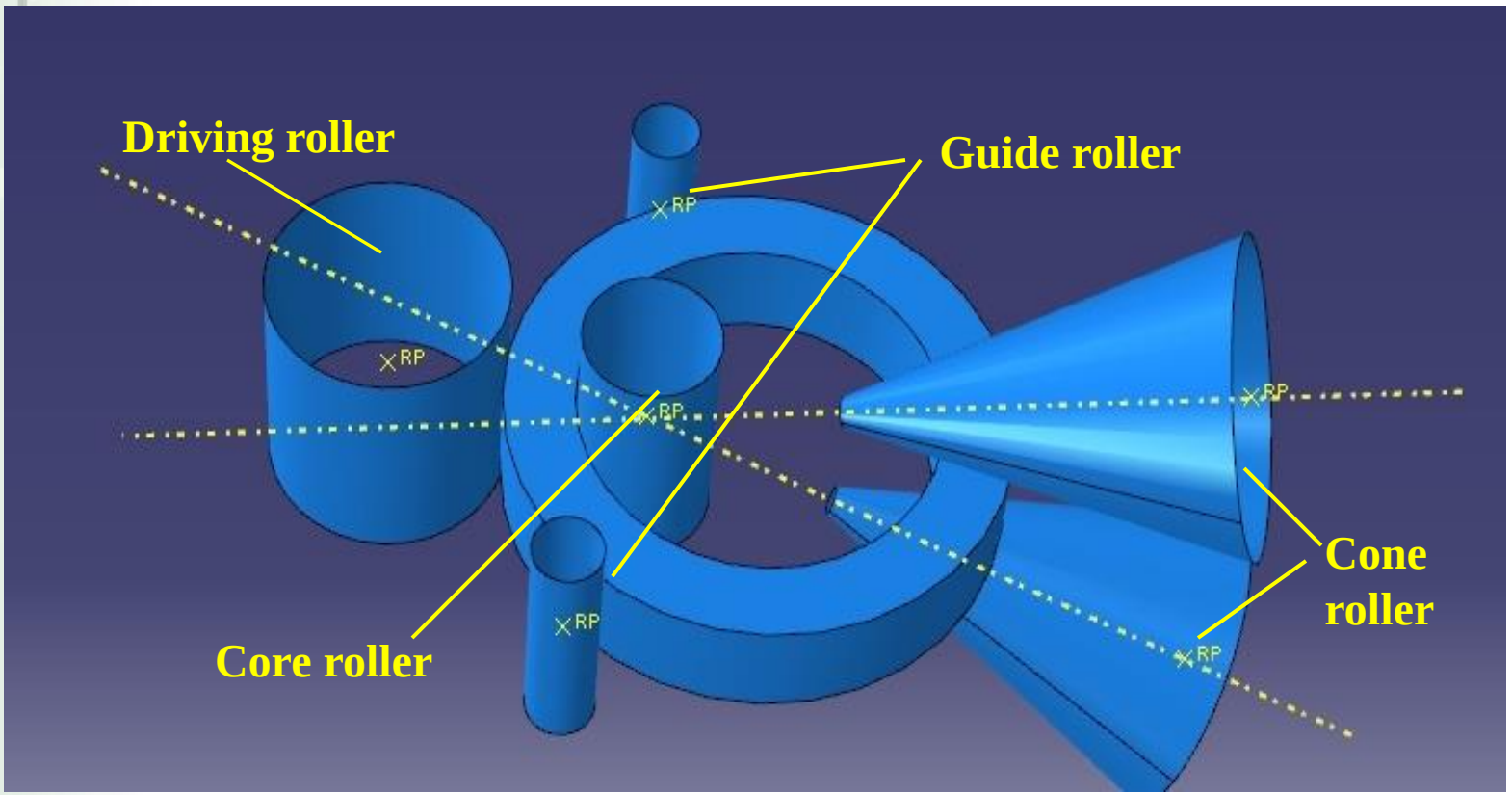
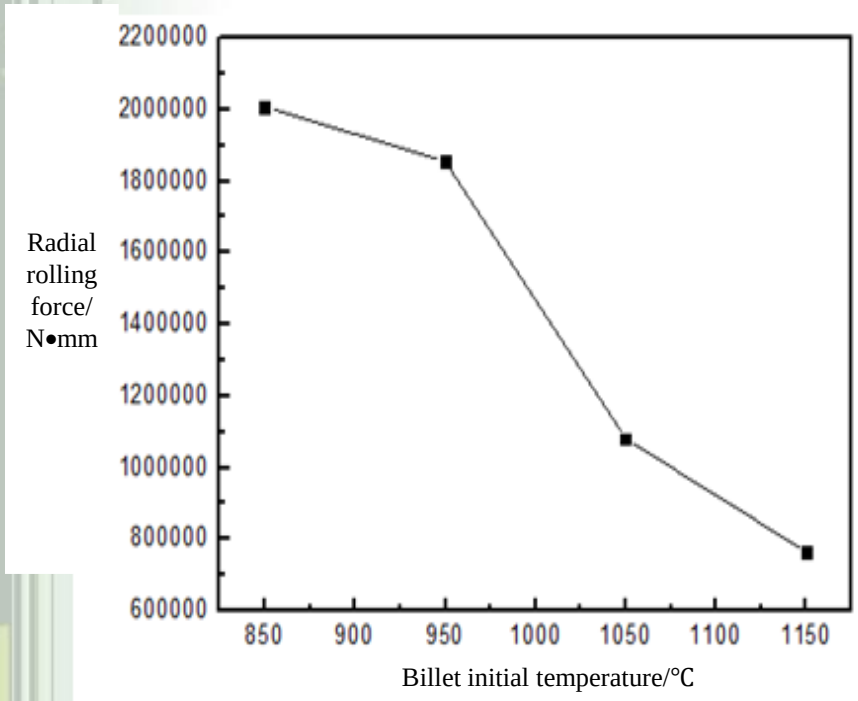
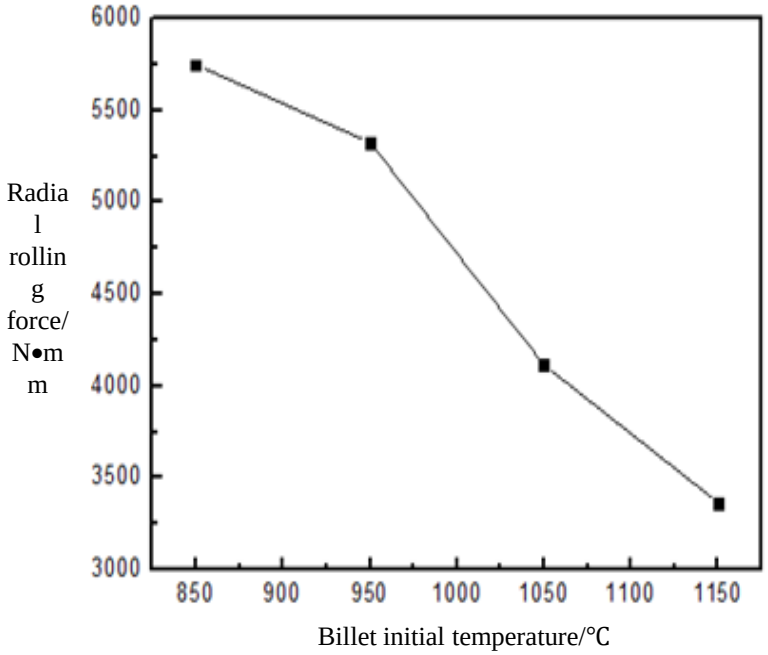


Fig.10 Principle diagram of radial-axial ring rolling

Results & Discussion Ⅲ

ⅰ.The initial rolling temperature



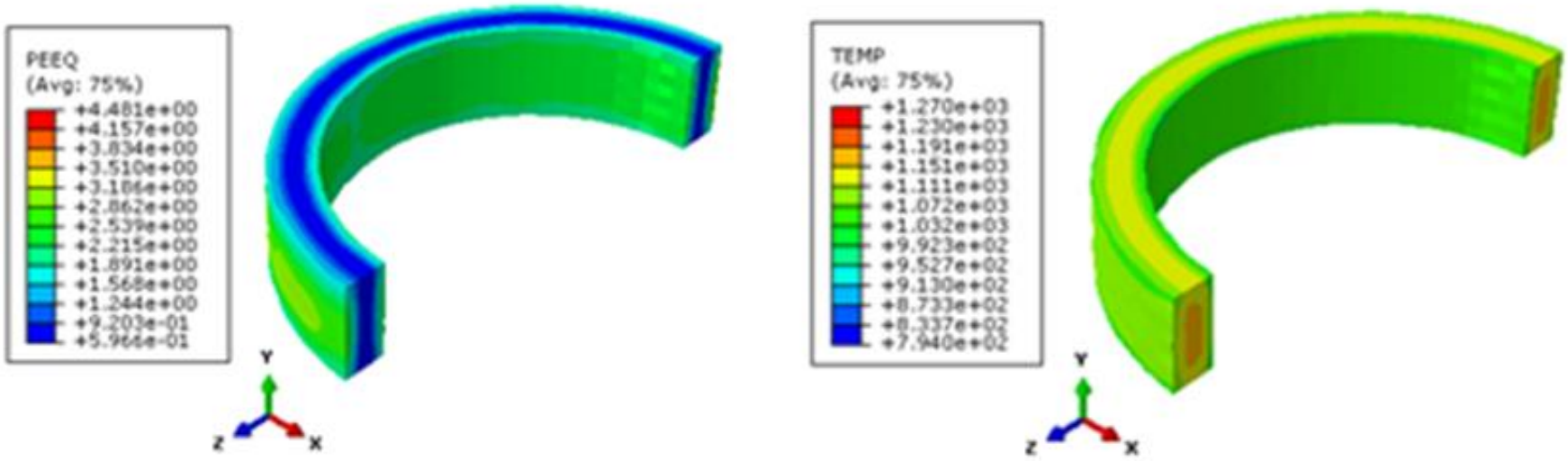


（a）The law about rolling force variation （b）The law about rolling torque

Fig.11 The effect of initial temperature on mechanics performance

Results & Discussion Ⅲ

ⅰ .The initial rolling temperature



(a)The distribution of equivalent strain (b) The distribution of temperature

Fig 12 The distribution of equivalent strain and temperature under 1150℃

The initial rolling temperature is 1150℃

Results & Discussion Ⅲ

ii .The rolling than

$$K = 13.73 - 13.02 \times \exp\left(-2 \times \left(\frac{d + 3.22}{18.6} \right)^2 \right) \qquad (2)$$

K —— rolling than

d ——inner diameter of the ring.

Substituting d=1045mm and K is 2.0.

Results & Discussion Ⅲ

ⅲ. The rotate speed of core roller

$$\left[v_{\min}\right]_{\max} \le v \le \left[v_{\max}\right]_{\min} \qquad (3)$$

$$\left[v_{\min}\right]_{\max} = \frac{n_1 R_1 \Delta h_{\min,0}}{2\Pi R_0} \qquad (4)$$

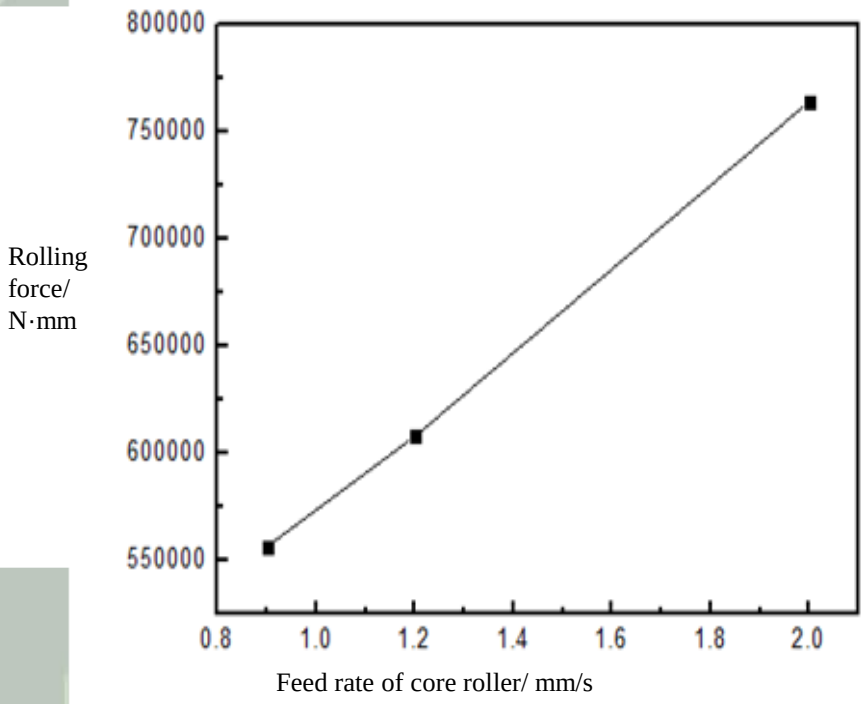
$$\left[v_{\max}\right]_{\min} = \frac{n_1 R_1 \Delta h_{\max,f}}{2\Pi R_f} \qquad (5)$$

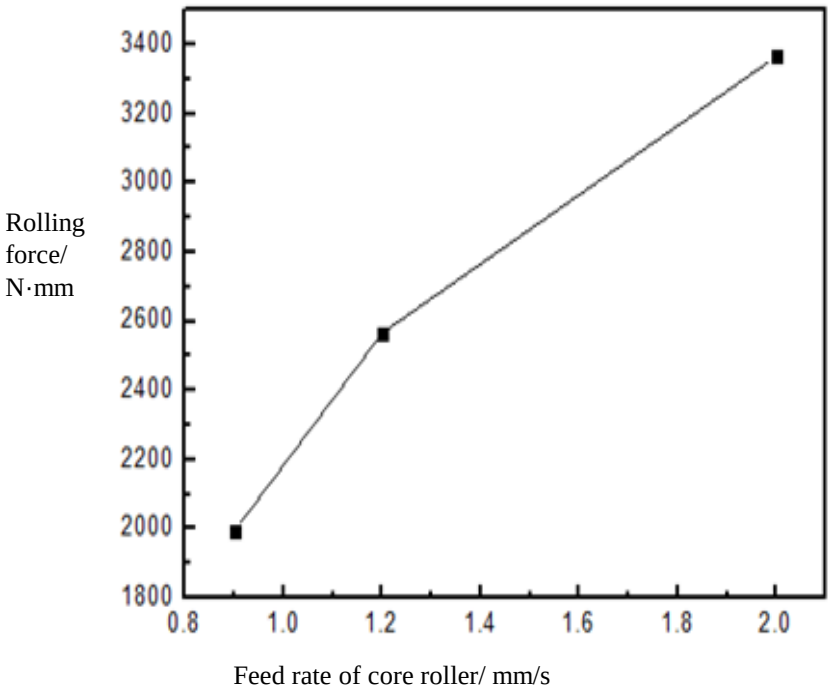
DK-3500 radial-axial ring rolling machine, set the rotate speed of driving roll 29.2r/min

The rotate speed of core roller is 0.35mm/s~2.57mm/s

Results & Discussion Ⅲ

ⅲ. The rotate speed of core roller





(a)The law about rolling force variation **(b)The law about rolling torque**

Fig.13 The effect of core roller feeding speed on mechanics performance

Conclusion

The main technological parameters of Casting-rolling continuously forming are as follows:

1. The smelting temperature, casting temperature and molding temperature of 42CrMo alloy are 1700℃, 1520℃ and 1050℃, respectively. The rotate speed of mold cast is 480r/min.

2. The heating temperature is 1050℃ in heat preservation process and preservation time is 30min. The ring cast is heated to rolling temperature of 1150℃at heating rate of 5℃/min and held for 5min.

3. The rolling than is 2 and the range of rotate speed of core roller is 0.35mm/s~2.57mm/s.

Achnoledgements

- Key of National Natural Science Foundation of China (51135007)
- National Natural Science Foundation of China (51174140, 51075290)
- National Natural Science Foundation for the Youth of China (51205270)
- Doctoral Program of Higher Education of China (20111415130001)
- Shanxi Scholarship Council of China (2011-084)

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Thank You !

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