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PROPERTIES AND MICROSTRUCTURE OF VERY PURE CrNiV STEEL

LASTNOSTI IN MIKROSTRUKTURA ZELO ČISTIH JEKEL CrNi

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The presented experiment is a part of the project aimed to the optimization of melting, casting, forming and heat treatment of high-purity steels with low contents of residual and deoxidation elements. Three ingots of the CrNiV steel with different refining degrees were investigated. Microstructure differences between top and bottom and between central and surface parts of ingot were determined. Changes of the microstructure of the cast steel after forming were described. Physical measurements were performed in order to obtain material parameters for the computer simulation of forming process. The temperature and deformation dependences on strain hardening and specific heat on temperature were measured.

Key words: high-purity steel, microstructure, physical measurement, simulation

Predstavljeni rezultati so del projekta s ciljem optimizacije taljenja, litja in toplotne obdelave zelo čistih jekel z majhno vsebnostjo rezidualnih in dezoksidacijskih elementov. Preiskave so bile izvršene na treh ingotih jekla CrNiV izdelanih z različno stopnjo rafinacije. Določene so bile razlike v mikrostrukturi med glavo in nogo ter srednjim delom ingotov. Opisane so spremembe mikrostrukture jekla po preoblikovanju. Fizikalne meritve so bile izvršene s ciljem, da se pridobijo podatki za računalniško simulacijo procesa preoblikovanja. Določene so bile odvisnosti deformacijskega utrujanja in specifične toplote od temperature.

Ključne besede: zelo čisto jeklo, mikrostruktura, fizikalne meritve, simulacija

1 INTRODUCTION

In paper the properties of the heat of very pure 26NiCrMoV115 steel are described. The chemical purity is an important condition besides optimal alloying for fulfilment of the requirements for a reliable use of steel components in power engineering. It is especially necessary to pay attention to obtain the appropriate relationship between strength and fracture toughness, fatigue and creep properties at operating temperature. All technological steps of steel production are being optimized, from melting and casting through forging of the ingot and the forming of the final component shape to the final heat treatment.

2 Results and discussion

The investigated material from the ingot with 1500 mm of diameter and 40 t of weight is specific with a very low content of deoxidation elements (Mn, Si, Al) and sulphur, **Table 1**.

Table 1: Chemical composition of investigated steel
Tabela 1: Kemijska sestava jekel, *w*/%

C	Mn	Si	P	S	Cr	Ni	Cu
0,293	0,202	0,013	0,004	0,006	1,637	2,820	0,011
Mo	**V**	**Al**	**As**	**Sn**	**Sb***	**Ca**	
0,405	0,117	0,010	0,003	0,001	0,004	0,001	

The microstructures of samples from different areas of the ingot was markedly heterogeneous (**Figure 1**). Bainite was found in dendrites and martensite in the inter-dendrite spaces. The bainite needles were larger in the top part of ingot than in the bottom part of the ingot. The size of dendrites near the surface was smaller than in the center of the ingot. Generally, the microstructure was coarse with typical size of grains of 100 µm.

A clear dependence of steel transition temperature was estabilished between the difference in microstructure of central and surface part of ingot (**Figure 2**). While the transition temperature was about 0 °C in the

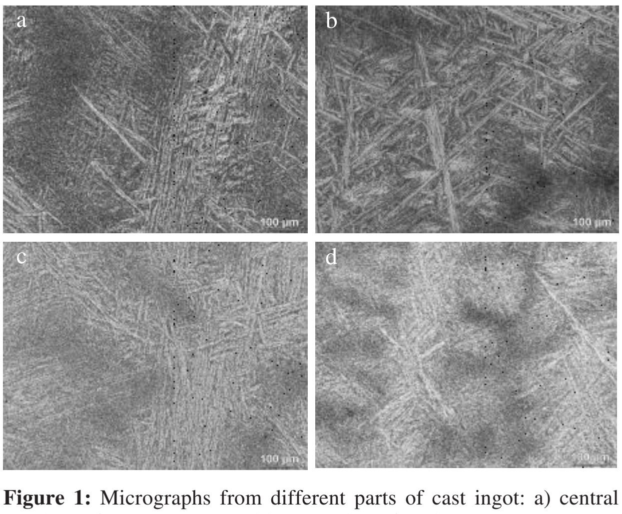

Figure 1: Micrographs from different parts of cast ingot: a) central top, b) surface top, c) central bottom, d) surface bottom
Slika 1: Mikroposnetki iz različnih delov ingota: a) glava-sredina, b) glava-površina, c) noga-sredina, d) noga-površina

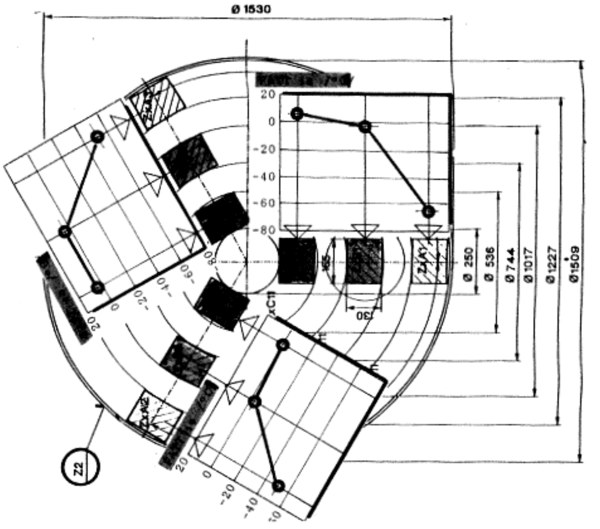

Figure 2: Transition temperature differences between central and surface parts of ingot

Slika 2: Razlika v prehodni temperaturi med notranjim in površinskim delom ingota

central part of ingots, the surface area of the ingot is substantially more resistant to brittle fracture.

The stress-strain dependence on temperatures was measured as one of the most important parameters for the computer modelling of forming processes. Experimental data were taken from tensile tests of resistance heated steel samples. By varying the stress-strain input data, series of iterative computer simulations were consequently performed to reach a good agreement between computed and measured records of loading force on the real sample and its model (**Figure 3**). Most of thermophysical data for simulation were taken from literature sources [1].

3 CONCLUSION

Three ingots of 40 t weight were cast and microstructures and transition temperatures in various parts of ingots were evaluated as initial steps of very pure CrNiV steel study. The stress-strain temperature dependences were measured and thermophysical properties were estimated to obtain data for the computer simulations of ingot forming. The process of ingot breakdown will be optimized with the aid of simulation. Resulting microstructures and material properties after forming will be compared with predictions obtained from simulations.

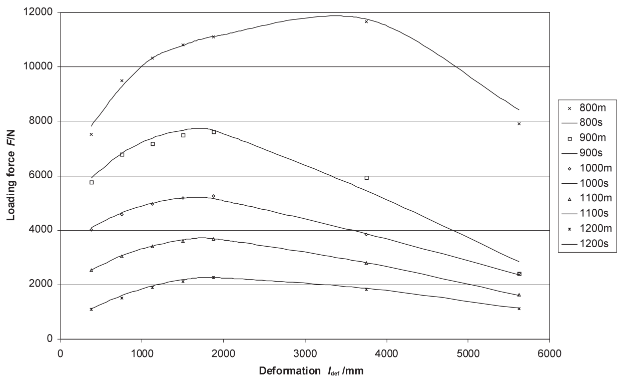

Figure 3: Comparison between measured simulated records of loading forces corresponding to tensile tests on CrNiV steel. The letter "m" represent measured records, and letter "s" computed records.

Slika 3: Primerjava med izmerjeno obremenitvijo, ki ustreza nateznemu preizkusu, in vrednostjo, določeno s simulacijo. Označba "m" je za izmerjeno, označba "s" pa za izračunano vrednost.

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