

## INFLUENCE OF MOLYBDENUM ON THE HOT-TENSILE PROPERTIES OF AUSTENITIC STAINLESS STEELS

### VPLIV MOLIBDENA NA NATEZNE LASTNOSTI V VROČEM AVSTENITNIH NERJAVNIH JEKEL

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*Prejem rokopisa – received: 2012-09-04; sprejem za objavo – accepted for publication: 2012-09-20*

Hot-tensile tests in the temperature range from 800 °C to 1200 °C were carried out on selected austenitic stainless steels containing mass fractions 0.6 % to 2.83 % of Mo with the aim being to study the effect of molybdenum on the mechanical properties. The tensile strength of the investigated steels decreased rapidly in the temperature range from 800 °C to 950 °C and slowly at the testing temperatures from 1000 °C to 1200 °C. In addition, the steel with the highest Mo content had a sharper decrease in the tensile strength. The temperature at which the maximum elongation was measured decreased with an increasing Mo content. It was found that molybdenum has a negative influence on the hot-ductility of austenitic stainless steels. In the steel with 2.83 % of Mo, the transformation from  $\delta$ -ferrite to  $\sigma$ -phase started at 1000 °C.

Keywords: austenitic stainless steels, hot-tensile properties, molybdenum

Na izbranih avstenitnih nerjavni jeklih, ki vsebujejo masne deleže Mo od 0,6 % do 2,83 %, so bili v temperaturnem območju med 800 °C in 1200 °C izvedeni vroči natezni preizkusi. Namen študije je ugotoviti vpliv molibdena na mehanske lastnosti. Natezne lastnosti jekel so hitro padale v temperaturnem območju med 800 °C in 950 °C in počasi v temperaturnem območju med 1000 °C in 1200 °C. Jeklo z najvišjo vsebnostjo molibdena pa je imelo ostrejši padec natezne trdnosti. Temperatura, pri kateri je bil izmerjen največji raztezek, je z vsebnostjo molibdena padala. Ugotovljeno je bilo, da ima molibden negativen vpliv na preoblikovanje v vročem. V jeklu z 2,83 % Mo se je fazna transformacija  $\delta$ -ferita v  $\sigma$ -fazo začela pri 1000 °C.

Ključne besede: avstenitno nerjavno jeklo, natezne lastnosti v vročem, molibden

## 1 INTRODUCTION

The hot cracking of stainless steels is a serious problem in many processes, and it has been a research topic for many years<sup>1-5</sup>. This cracking can occur both above the liquation temperature (supersolidus cracking) and in the solid state (subsolidus cracking), e.g., during casting, welding or hot working<sup>1</sup>.

The solidification behaviour of austenitic stainless steels depends on the chemical composition as well as on the cooling rate; both determine the solidification sequence and the microstructure evolution.

The solidification mechanism of austenitic stainless steels is of four types<sup>6</sup>: austenitic (A), austenitic-ferritic or primary austenitic (AF), ferritic-austenitic or primary ferritic (FA) and ferritic (F) (Table 1).

An addition of mass fractions 0.3 % to 2.7 % Mo enhances the pitting-corrosion resistance of austenitic stainless steels, reduces the corrosion-progression rate and increases the critical pitting temperature<sup>7</sup>. The aim of this work is to investigate the effect of molybdenum on the mechanical properties of austenitic stainless steels.

However, in industrial conditions austenitic stainless steels solidify in non-equilibrium conditions and a two-phase microstructure of austenite and  $\delta$ -ferrite can form<sup>8</sup>.  $\delta$ -ferrite differs from an austenite matrix in its crystallography and chemical composition and is therefore likely to provide crack-nucleation sites<sup>5</sup>.

In many continuous-casting plants the secondary cooling is chosen on the basis of ductility data from the tensile tests in order to avoid surface cracks<sup>9,10</sup>.

That is why the hot-tensile tests for the selected unstabilized austenitic stainless steels containing 0.6 %

**Table 1:** Solidification mechanisms of austenitic stainless steels<sup>6</sup>

**Tabela 1:** Mehanizem strjevanja avstenitnih nerjavni jekel<sup>6</sup>

$(Cr_{eq}/Ni_{eq})$	Solidification mechanism	Mode
$(Cr_{eq}/Ni_{eq}) < 1.25$	$L \rightarrow L + \gamma_{prim.} \rightarrow \gamma$	A
$1.25 < (Cr_{eq}/Ni_{eq}) < 1.48$	$L \rightarrow L + \gamma_{prim.} \rightarrow L + \gamma + \delta \rightarrow \gamma + \delta$	AF
$1.48 < (Cr_{eq}/Ni_{eq}) < 1.95$	$L \rightarrow L + \delta_{prim.} \rightarrow L + \delta + \gamma \rightarrow \gamma + \delta$	FA
$(Cr_{eq}/Ni_{eq}) > 1.95$	$L \rightarrow L + \delta_{prim.} \rightarrow \delta \rightarrow \gamma + \delta$	F

L is liquid;  $\gamma$  is austenite;  $\delta$  is delta ferrite; A is austenitic; AF is austenitic-ferritic; FA is ferritic-austenitic; F is ferritic

to 2.83 % Mo were performed in the temperature range from 800 °C to 1200 °C.

## 2 EXPERIMENTAL

### 2.1 Materials

Unstabilized austenitic stainless steels containing 0.6 % to 2.83 % of Mo were tested in this investigation. The hot-rolled, solution-annealed specimens of steel grades AISI 304, AISI 316L, X2CrNiMo 17-12-3 and X2CrNiMo 18-14-3 were used. The chemical compositions of the investigated steels are shown in **Table 2**.

The chromium and nickel equivalents calculated according to equations 1 and 2 are given in **Table 2**<sup>1</sup>.

$$Cr_{eq} = (Cr) + 2 (Si) + 1.5 (Mo) + 5 (V) + 5.5 (Al) + 1.75 (Nb) + 1.5 (Ti) + 0.75 (W) \quad (1)$$

$$Ni_{eq} = (Ni) + (Co) + 0.5 (Mn) + 0.3 (Cu) + 25 (N) + 30 (C) \text{ (in mass fractions } w \text{ (\%))} \quad (2)$$

**Table 2:** Chemical compositions of the investigated steels (in mass fractions, w/%)

**Tabela 2:** Kemijska sestava preiskovanih jekel (v masnih deležih, w/%)

Elements	AISI 304	AISI 316L	X2CrNiMo 17-12-3	X2CrNiMo 18-14-3
C	0.049	0.016	0.025	0.02
Si	0.46	0.48	0.33	0.34
Mn	1.60	1.49	1.6	1.53
P	0.036	0.030	0.039	0.032
S	0.001	0.002	0.002	0.002
Cr	18.22	16.6	16.99	17.85
Ni	8.29	10.03	10.62	12.83
Cu	0.39	0.32	0.34	0.38
Mo	0.60	2.06	2.51	2.83
Al	0.007	0.005	0.006	0.007
V	0.05	0.04	0.05	0.05
Ti	0.004	0.001	0.005	0.005
Nb	0.010	0.004	0.005	0.005
N	0.0870	0.0239	0.0478	0.0338
Cr <sub>ekv</sub>	20.58	20.89	21.71	23.04
Ni <sub>ekv</sub>	13.07	11.70	13.47	15.46
Cr <sub>eq</sub> /Ni <sub>eq</sub>	1.57	1.79	1.61	1.49

The selected steels have low and medium carbon contents and no additions of the elements with a high affinity towards carbon and nitrogen, e.g., titanium and niobium.

According to Cr<sub>eq</sub>/Ni<sub>eq</sub>, all the selected steels solidify in the FA mode, with the primary precipitation of δ-ferrite<sup>6</sup>.

### 2.2 Hot-tensile tests

The hot-tensile-test specimens were prepared according to the standard EN-10002-5:1991 (DIN 50125). The specimens were cut out from hot-rolled plates transverse to the rolling direction. The dimensions of the specimens were as follows: a length of 1200 mm, a width of 20 mm, and a thickness of 20 mm.

The tensile tests were performed in the hot-rolling temperature range from 800 °C to 1200 °C. The tests were carried out using a 500 kN Instron static-dynamic testing machine. The cross-head speed was 5 mm/min. The heating rate was 600 °C/h. Prior to the tensile tests the specimens were held at the temperatures of the experiments for 20 min. During the hot-tensile tests force and extension were simultaneously recorded.

### 2.3 Metallography

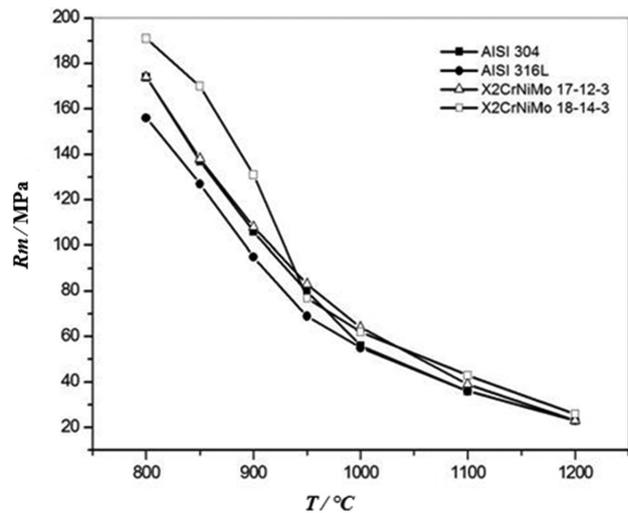
Metallographic specimens were cut out from the area of uniform elongation. The specimens were metallographically prepared by grinding, polishing and then etching in a solution of 10 ml HNO<sub>3</sub> + 10 ml Acetic Acid + 15 ml HCl. A Microphot FXA-Nikon light microscope equipped with a Hitachi HV-C20AMP 3CCD video camera, and a JEOL JSM-5610 scanning electron microscope were used. The Vickers hardness HV1 was measured using an Instron Wilson-Wolpert Tukon 2100B hardness tester in accordance with ISO 6507-1:2006. The content of the magnetic δ-ferrite was determined by a ferritoscope instrument FISCHER MP30 after a 20-minute annealing of the specimens at the set temperature. The grain size of the specimens was assessed by light microscopy.

## 3 EXPERIMENTAL RESULTS

### 3.1 Hot-tensile tests

The mechanical properties of the investigated steels measured during the hot-tensile testing are given in **Table 3**.

The comparison of the results for the selected steels (**Table 3**) shows the similar behaviour of AISI 304 and X2CrNiMo 17-12-3 during the hot-tensile testing at the temperatures of 800 °C, 850 °C, 900 °C, 1100 °C, and



**Figure 1:** Temperature dependence of the tensile strength of the tested austenitic stainless steels with various contents of molybdenum

**Slika 1:** Temperaturna odvisnost natezne trdnosti jekel z različnimi vsebnostmi molibdena

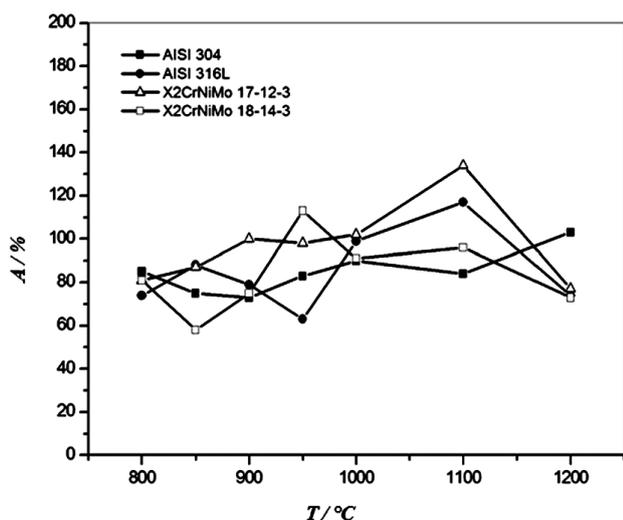


Figure 2: Temperature dependence of the elongation of the tested austenitic stainless steels with various contents of molybdenum

Slika 2: Temperaturna odvisnost raztezka preizkušanih avstenitnih jekel z različnimi vsebnostmi molibdena

Table 3: Tensile properties of the steels in the temperature range from 800 °C to 1200 °C

Tabela 3: Natezne lastnosti pri vročem nateznem preizkusu v temperaturnem območju med 800 °C in 1200 °C

Steel type	Temperature	Force	Strength	Elongation	Reduction of area
	T	F	$R_m$	A	Z
	°C	kN	MPa	%	%
AISI 304	800	13.57	174	85	83
	850	10.65	137	75	83
	900	8.27	106	73	92
	950	6.25	80	83	98
	1000	4.4	56	90	99
	1100	2.8	36	84	98
AISI 316L	800	12.25	156	74	65
	850	10	127	88	96
	900	7.47	95	79	91
	950	5.35	69	63	60
	1000	4.25	55	99	94
	1100	2.8	36	117	90
X2CrNiMo 17-12-3	800	13.57	174	81	81
	850	10.8	138	87	84
	900	8.425	108	100	96
	950	6.45	83	98	97
	1000	5	64	102	95
	1100	3.075	39	134	84
X2CrNiMo 18-14-3	800	14.9	191	81	86
	850	13.22	170	58	85
	900	10.15	131	75	92
	950	5.9	77	113	96
	1000	4.85	62	91	81
	1100	3.3	43	96	69
1200	2.05	26	73	67	

1200 °C, where the tensile strengths were about the same. Minor differences between the steels were observed during the testing at 950 °C and 1000 °C

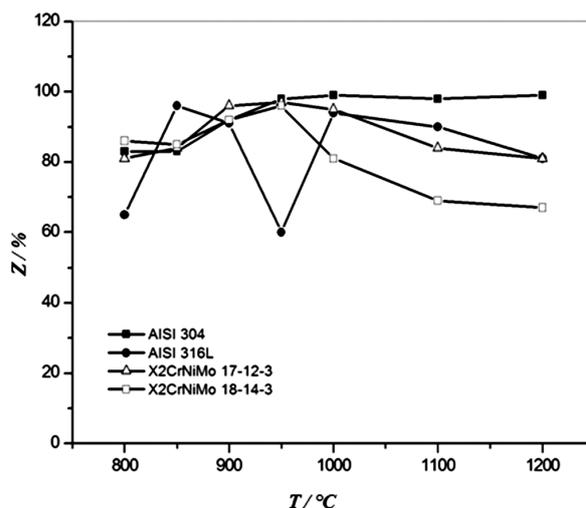


Figure 3: Reduction of area at different testing temperatures for selected austenitic stainless steels with various content of molybdenum

Slika 3: Kontraktacija pri različnih temperaturah preskusov izbranih avstenitnih nerjavnih jekel z različnimi vsebnostmi molibdena

(Figure 1). On the other hand, the AISI 316L and X2CrNiMo 18-14-3 steel-tensile-strength values differ significantly in the temperature range from 800 °C to 900 °C. Much lower tensile strengths were measured in the case of AISI 316L and much higher tensile strengths were obtained for X2CrNiMo 18-14-3. At the higher temperatures of 1100 °C and 1200 °C, X2CrNiMo 18-14-3 that contains 2.83 % Mo had the highest tensile strength.

The temperature of the maximum elongation of the examined steels decreased with the increasing Mo content. At 1200 °C, AISI 304 had the highest elongation (Figure 2).

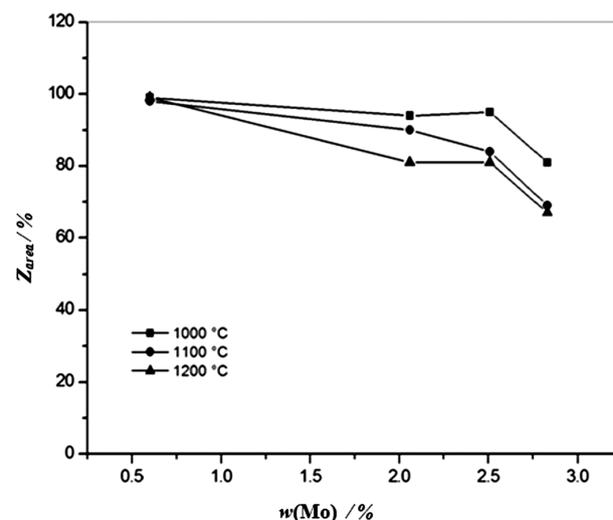


Figure 4: Influence of molybdenum on the reduction of area of the austenitic stainless steels in the temperature range of 1000–1200 °C

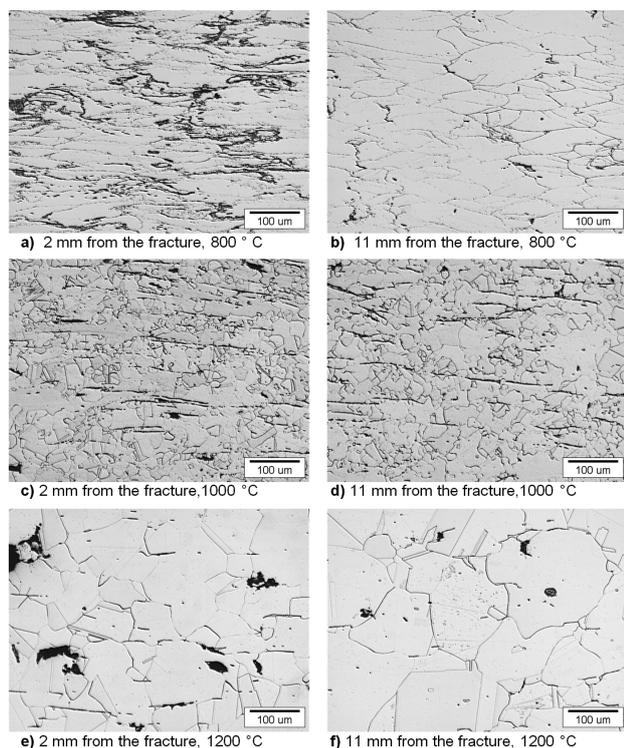
Slika 4: Vpliv molibdena na kontraktacijo avstenitnih nerjavnih jekel v temperaturnem območju med 1000 °C in 1200 °C

The dependence of the reduction of area on the testing temperature is shown in **Figure 3**. The values of the area reduction are the highest for AISI 304, which has the lowest content of molybdenum. At higher temperatures, e.g., 1000 °C to 1200 °C, the reduction of area decreases with an increasing content of molybdenum.

The lowest values of the reduction of area for the X2CrNiMo 18-14-3 steel at the testing temperatures of 1100 °C and 1200 °C were found to be 69 % and 67 %, respectively (**Figure 4**).

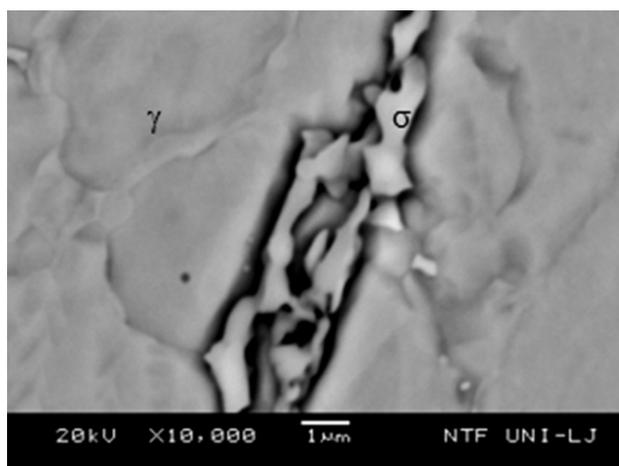
### 3.2 Metallography

Typical microstructures in the striction area of the fractured tensile specimens of the X2CrNiMo 17-12-3 steel are shown in **Figure 5**. The morphology of the  $\sigma$ -phase in the X2CrNiMo 17-12-3 steel after testing at 850 °C and 900 °C is shown in **Figures 6** and **7**. The effect of temperature on the hardness in the striction areas of the fractured specimens of the X2CrNiMo 18-14-3 steel is shown in **Figure 8**. The hardness decreases with the increasing temperature (**Figure 8**). The highest values of hardness were measured after the tensile testing at 800 °C. Moreover, at a lower testing



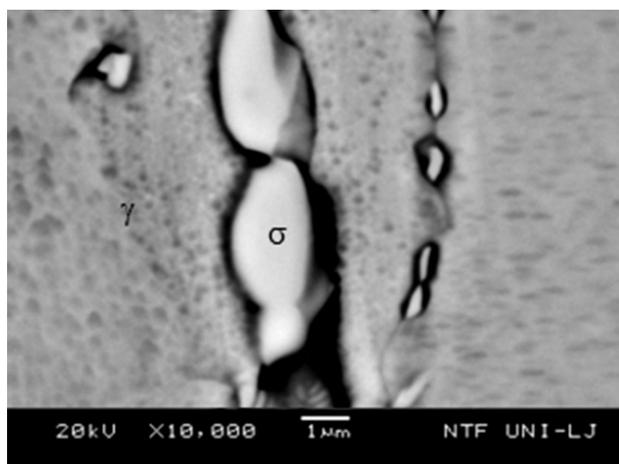
**Figure 5:** Typical microstructures in the striction areas of the fractured tensile specimens of X2CrNiMo 17-12-3: a) 2 mm from the fracture, 800 °C; b) 11 mm from the fracture, 800 °C; c) 2 mm from the fracture, 1000 °C; d) 11 mm from the fracture, 1000 °C; e) 2 mm from the fracture, 1200 °C; f) 11 mm from the fracture, 1200 °C

**Slika 5:** Tipična mikrostruktura strižnega območja preloma preizkušancev X2CrNiMo 17-12-3: a) 2 mm od preloma, 800 °C; b) 11 mm od preloma, 800 °C; c) 2 mm od preloma, 1000 °C; d) 11 mm od preloma, 1000 °C; e) 2 mm od preloma, 1200 °C; f) 11 mm od preloma, 1200 °C



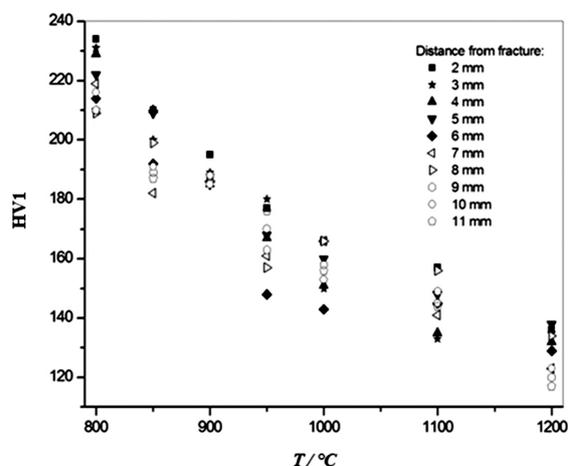
**Figure 6:** SE image of the  $\sigma$ -phase in the X2CrNiMo 17-12-3 steel after the testing at 850 °C

**Slika 6:** SE-posnetek  $\sigma$ -faze v jeklu X2CrNiMo 17-12-3 po preizkusu na 850 °C



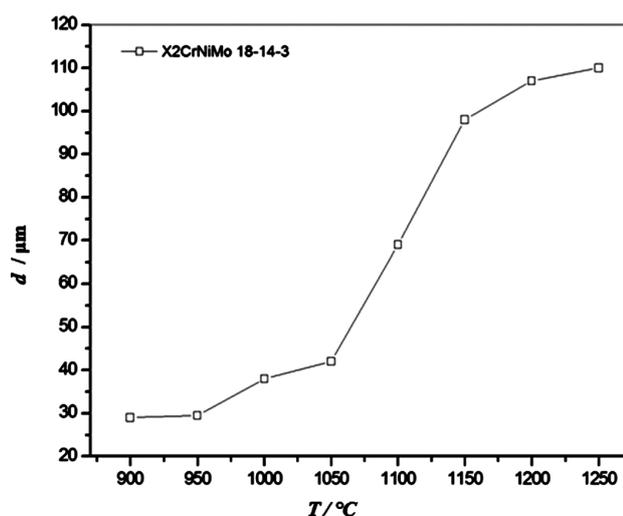
**Figure 7:** SE image of the  $\sigma$ -phase in the X2CrNiMo 17-12-3 steel after the testing at 900 °C

**Slika 7:** SE-posnetek  $\sigma$ -faze v jeklu X2CrNiMo 17-12-3 po preizkusu na 900 °C



**Figure 8:** Hardness of X2CrNiMo 18-14-3 in the reduction areas of the tensile specimens in dependence of the test temperature

**Slika 8:** Trdota X2CrNiMo 18-14-3 v območju kontrakcije v odvisnosti od temperature



**Figure 9:** Grain size  $d$  of X2CrNiMo 18-14-3 after being held for 20 minutes at different annealing temperatures

**Slika 9:** Velikost zrn  $d$  v jeklu X2CrNiMo 18-14-3 po 20-minutnem zadržanju pri različnih temperaturah žarenja

temperature, e.g., 800 °C and 900 °C hardness decreases with the increasing distance from the fracture.

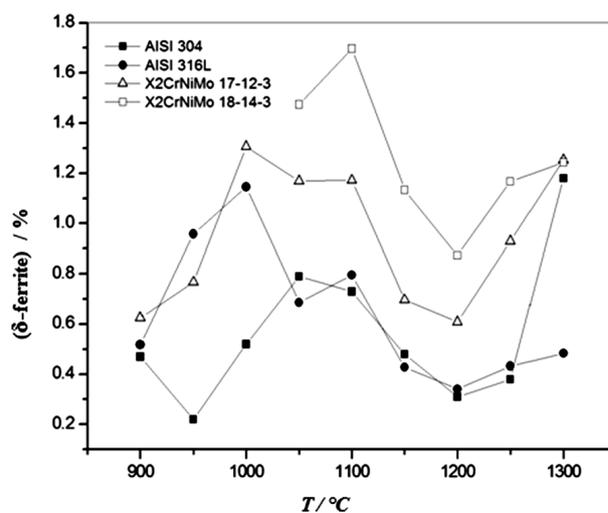
The change in the austenite grain of the X2CrNiMo 18-14-3 steel exposed to the annealing temperature for 20 minutes is shown in **Figure 9**. The greatest increase in the grain size, together with an increasing temperature of X2CrNiMo 18-14-3, was measured in the temperature range from 1050 °C to 1200 °C. An unstable microstructure, e.g., the grain growth, can impair the workability of the steel.

The  $\delta$ -ferrite content in the investigated steels was measured after 20 minutes of annealing. The amount of  $\delta$ -ferrite was on an increase with the increasing molybdenum content up to 1250 °C. In X2CrNiMo 18-14-3,  $\delta$ -ferrite could not be detected at the temperatures lower than 1050 °C.

#### 4 DISCUSSION

The hot workability of steels depends on the material properties and on the hot-working process. According to the equilibrium-phase diagrams the presented austenitic stainless steels selected for this study solidify with the primary formation of  $\delta$ -ferrite.

In the industrial conditions, austenitic stainless steels are subjected to non-equilibrium solidification that produces a two-phase microstructure of austenite and  $\delta$ -ferrite. Depending on the content of the base elements and the other alloying elements as well as impurities, which may enhance the stability of the  $\gamma$ -phase or  $\alpha$ -phase, the solidification is started with the primary formation of austenite or ferrite. The steels with the initial austenite solidification are more sensitive to the solidification-boundary segregation and hot cracking.



**Figure 10:** Content of  $\delta$ -ferrite in the investigated steels in dependence of the annealing temperature

**Slika 10:** Vsebnost  $\delta$ -ferita v preiskovanih jeklih v odvisnosti od temperature žarenja

The results of the hot-tensile tests in the temperature range from 800 °C to 1200 °C indicate that molybdenum influences their mechanical properties. Molybdenum is a strong ferrite stabilizer as seen in equation (1). Molybdenum is reported to affect the static recrystallization and the rate of the static recrystallization in austenitic stainless steel. The static recrystallization during the hot-compression experiments at the temperatures from 1050 °C to 1250 °C was delayed by a factor of about 1.7 when the molybdenum content was raised from mass fractions 2.5 % to 4.5 % of Mo.<sup>12</sup> Molybdenum affects the ductility of austenitic stainless steels, decreases workability and increases resistance to deformation below 1000 °C. At higher temperatures the softening process is fast enough to compensate for the effect of molybdenum on deformation resistance and deformability.

In the temperature range from 800 °C to 950 °C, the strength of the steels with higher nickel, chromium and molybdenum contents (X2CrNiMo 17-12-3, X2CrNiMo 18-14-3) was higher, by about 20 N/mm<sup>2</sup>, than that of AISI 316L. The results of this study have shown that the tensile strength of all the specimens decreased with the increasing temperature. However, this strength decrease was sharp in the temperature range from 800 °C to 950 °C and slow at the testing temperatures of 1000 °C to 1200 °C. In addition, the strength decrease was sharper for X2CrNiMo 18-14-3 that had the highest Mo content. X2CrNiMo 18-14-3 ( $w(\text{Mo}) = 2.83\%$ ) showed the highest tensile strength of all the specimens tested at 1100 °C and 1200 °C.

The comparison of the results for the selected steels has shown a similar behaviour of AISI 304 and X2CrNiMo 17-12-3 during the hot-tensile testing at the temperatures of 800 °C, 850 °C, 900 °C, 1100 °C, and 1200 °C, where the tensile strengths were the same. The

AISI 304 steel has higher contents of nitrogen and carbon in mass fractions (0.0870 % N, 0.049 % C and 0.6 % Mo in AISI 304 versus 0.0478 % N, 0.025 % C and 2.51 % Mo in X2CrNiMo 17-12-3, Table 1). AISI 304 has a slightly higher tensile strength compared to AISI 316L, which can be correlated to the higher contents of carbon and nitrogen. Carbon and nitrogen have a significant effect on the yield strength even in small quantities; they are among the most effective strengtheners<sup>13</sup>. Nitrogen is an element that enhances the formation and stability of austenite and enlarges the austenite-phase range<sup>13</sup>. It increases both the yield strength and the ultimate tensile strength without a loss of ductility and toughness<sup>14</sup>. Nitrogen also improves the local corrosion resistance, especially the pitting- and crevice-corrosion resistance<sup>15</sup>. The solubility of nitrogen in stainless steels depends, for practical steelmaking purposes, on three major factors: temperature, pressure and chemical composition. Solubility decreases considerably at the temperatures below 1000 °C.<sup>13</sup> Chromium-nitride precipitation in the austenitic stainless steels with the commercial levels (<0.1 %) of nitrogen usually occurs on the grain boundaries, inside the grains and at the dislocations. Most alloying elements increase the nitrogen solubility (Cr, Mn and Mo), but the most important element, nickel, lowers the nitrogen solubility.

The temperature, at which the maximum elongation was measured, decreased with the increasing Mo content. The highest percentage of the elongation of X2CrNiMo 18-14-3 was measured at 950 °C, and that of AISI 316L and X2CrNiMo at 1100 °C. At 1200 °C the elongation of the steel grades with >2 % Mo diminished significantly. On the other hand, the elongation of AISI 304, containing 0.6 % Mo, was the highest at 1200 °C (**Figure 2**).

Molybdenum was found to have a negative influence on the hot ductility of austenitic stainless steels. The lowest values of the reduction of area were measured for X2CrNiMo 18-14-3 at the testing temperatures of 1100 °C and 1200 °C, 69 % and 67 %, respectively (**Figures 3, 4**).

Reduction of area can be taken as a measure of ductility. A low value of reduction of area indicates brittleness of the material. High reduction-of-area values (approaching 100 %) indicate a ductile material state<sup>9</sup>. Furthermore, it has been reported that steel plates did not form transverse cracks on the straightening and network cracks when the surface temperature of the slab was maintained in the temperature ranges, in which the reduction of area was above 75 %<sup>14</sup>.

The measured hardness decreases with the increasing temperature (**Figure 8**). The highest values of the hardness were measured after the tensile tests at 800 °C. At the lower testing temperatures, e.g., 800 °C and 900 °C, the hardness decreases with the increasing distance from the fracture. These results could indicate the presence of the deformation-dependent  $\sigma$ -phase. The phase transformation of  $\delta \rightarrow \gamma + \sigma$  in austenitic stainless steels

is enhanced with the increasing reduction ratio during hot rolling. The precipitation of  $\sigma$ -phase can be regarded as a (dispersion) strengthening mechanism for austenitic stainless steels<sup>15</sup>.

The plastic deformation strongly affects the kinetics of the  $\sigma$ -phase formation. A thin layer of ferrite with a lowered content of molybdenum was found in the middle of the  $\sigma$ -phase layer in the microstructure of the specimens tested at a temperature below 1000 °C. The formation of the  $\sigma$ -phase starts with a nucleation at the austenite-ferrite phase boundary where it grows at the expense of the ferrite phase. By growing, the formed  $\sigma$ -phase extracts chromium and molybdenum from the ferrite. The content of molybdenum in the  $\sigma$ -phase was between mass fractions 4 % and 8 % and that of chromium was above 25 %, while the neighbouring austenite contained about 1 % to 2 % Mo and 17 % to 18 % Cr.

The amount of  $\delta$ -ferrite increased with the increasing molybdenum content (**Figure 10**).  $\delta$ -ferrite could not be detected in X2CrNiMo 18-14-3 at the temperatures below 1050 °C. This could indicate the presence of the non-magnetic  $\sigma$ -phase. The measured values of the  $\delta$ -ferrite content could reveal that the reheating of austenitic stainless steels above 800 °C results in a transformation of the non-magnetic  $\sigma$ -phase (and Chi-phase) into  $\delta$ -ferrite. The magnetic  $\delta$ -ferrite becomes stable at the temperatures above 1200 °C.

Ferrite is an unstable phase in austenitic stainless steels and its content is diminished by keeping the steel at a temperature that allows a sufficient diffusion rate of the elements in the substitutional solid solution. The highest content of ferrite was present at the testing temperature of 1000 °C. However, the content of ferrite was not changed sufficiently to affect the steel deformability. Moreover, the change of the shape of the ferrite phase in the microstructure, mainly at the beginning of spheroidisation, did not affect the deformability. The process of the shape change described by the shape factor represents the relations between the nominal diameter and the length ( $d/l$ ) and between the share of the mutually connected ferrite areas and the total number of inserts ( $DOI$ ). The value of the shape factor increases with the annealing temperature, while the  $DOI$  relation is lower at higher temperatures and longer annealing times<sup>16</sup>.

Nucleation normally occurs mostly at the phase boundaries between austenite and  $\delta$ -ferrite, where the migration of the atoms to the potential  $\sigma$ -phase nucleation points is faster. The atoms of chromium and molybdenum diffuse from  $\delta$ -ferrite to  $\sigma$ -phase in the process of growth. At the higher temperatures  $\sigma$ -phase is spheroidised to isolate the grains (**Figures 6, 7**).

In X2CrNiMo 18-14-3, which has the highest molybdenum of all the tested steel grades, the transformation of  $\delta$ -ferrite to the hard and brittle  $\sigma$ -phase had presumably started at the temperature of 1000 °C.

The brittleness of stainless steel increases if a  $\sigma$ -phase is present.

## 5 CONCLUSIONS

The hot-tensile tests were carried out in the temperature range from 800 °C to 1200 °C on the selected austenitic stainless steels containing from 0.6 % to 2.83 % of Mo. The mechanical properties of the steels were investigated and the following results were obtained:

- The tensile strength of the specimens decreased with higher temperatures. The decrease in the strength was sharp in the temperature range between 800 °C and 950 °C and slow between 1000 °C and 1200 °C. In addition, the decrease in the strength was sharper for the steel with the highest Mo content.
- The temperature, at which the maximum elongation was measured, decreased with the increasing Mo content.
- Molybdenum was found to have a negative influence on the hot ductility of austenitic stainless steels. The reduction of area for unstabilized stainless steel containing 2.83 % Mo reached its critical values at the hot-tensile-testing temperatures of 1100 °C and 1200 °C.
- The transformation of  $\delta$ -ferrite to  $\sigma$ -phase in X2CrNiMo 18-14-3 ( $w(\text{Mo}) = 2.83\%$ ) presumably started at 1000 °C.

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