MICROSTRUCTURAL ASPECTS OF STRENGTH AND PLASTICITY OF NITROGEN ALLOYED WELD METAL IN TENSILE AND IMPACT TESTS

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The investigation is carried on Cr - Ni - Mn weld metal, additionaly alloyed with nitrogen in the concentration range 0 - 0,6 %, tested in tensile and impact conditions.Dislocation substructure in zones nearest to the fractured surface at room and cryogenic temperatures is observed. Special attention is given to the influence of nitrogen on the dislocation reactions and mechanical properties. Some conclusions are made about dependences between properties, structure and test conditions.

Nitrogen is known to improve the strength and toughness of weld joints from austenitic stainless steels, especially at low and cryogenic temperatures (1).We tried to find some explanation to this fact for two systems of steels: A - containing 25% Cr,20% Ni,4% Mn and B - with 19% Cr,6% Ni,8% Mn. Nitrogen content is varied in the range 0 - 0,64%, while carbon is kept in the limits 0,03 - 0,06%.

Nitrogen causes considerable increase of σ_{ys} in both systems at room and cryogenic temperatures, but with some difference in the curves character (Fig.1). In system A strengthening rate decreases in the whole concentration interval,while in system B some increase appears after 0,28%. This difference can be related to the different influence of N on the dislocation structure in both systems. System A possesses a planar distribution of dislocations independent on the N concentration such structure was observed in many austenitic steels with high Cr and Ni content and was explained first by Douglas (2) due to short range order in the hard solution.

In absence of N system B contains some ferrite of vermicular type.Austenitic grains show three-dimensional dislocation distribution,that means relatively high SFE (Fig.3a). Alloying with N obviously decreases SFE,and the dislocation structure changes to two-dimensional with copla-

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nar arrays of dislocations (fig.3b).The restricted cross-slip increases the resistence against movement of dislocations through crystal lattice and causes the observed increase in strengthening rate in system B.The same processes probably cause the rapid decrease of A5 in system B in austenitic region (after 0,28% N).

KCV shows a very slight dependence on N content in both systems and at both temperatures in the range 0 - 0,3% N. At higher concentrations KCV decreases,especialy at room temperature.At -196°C its value is much less sensitive to N content.The only exception is the sharp drop at 0,64%N in system A, where we found particles of Cr nitride along grain boundaries. The value of J,calculated for this temperature,shows the same dependence. The smaller influence of N on KCV at cryogen temperature is difficult to explain on the basis of its behaviour as an interstitial atom in austenitic lattice.The other factor - the influence of low temperature on the mode of dislocation movement and reactions - is not very clear.Glaser (3) reports some observations on the system Al-Li,where he has found „a decrease of planar slip" and „more homogenous deformation" at cryogenic temperatures. We investigated thin foils, cut most near to the fractured surface of impact (at -196,-120 and -80°C) and tensile (at -196°C) specimens.Several examples of the microstructures for different N levels are shown in fig. 3, 4, 5. The following peculiarities can be mentioned :

1)When decreasing temperature in impact fractured specimens the tendency to planar distribution of dislocations decreases.This observation is valid for both systems,so it must be related to SFE changes more probably,than to short range order.

2)When decreasing temperature in impact fractured specimens the dislocations thickness increases.This corresponds with their decreasing movability and ability for relaxation,but it means also increased ability of sources to produce them.

3)The tensile fractured specimens show a structure with lower density and planar distribution of dislocations - features,which are typical for higher temperatures in impact fractured specimens.This means,that „the more homogenous deformation" is a characteristic of the dynamic conditions of loading.

SYMBOLS USED

SFE - stacking faults energy
KCV - V-notch impact toughness

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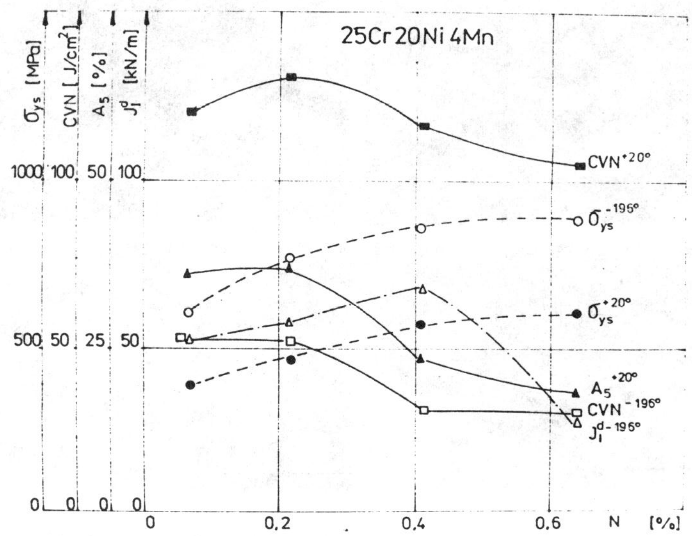

Fig.1. Influence of N on properties in system A

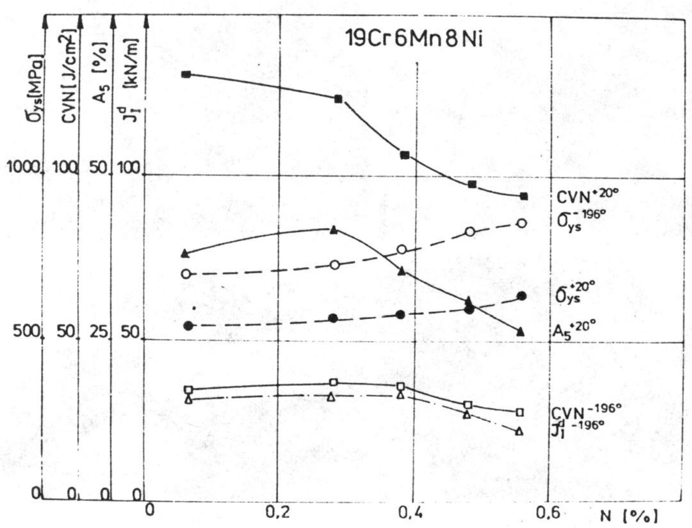

Fig.2. Influence of N on properties in system B

Fig.3. Dislocation structure in system B
0 % N b) 0.56 % N

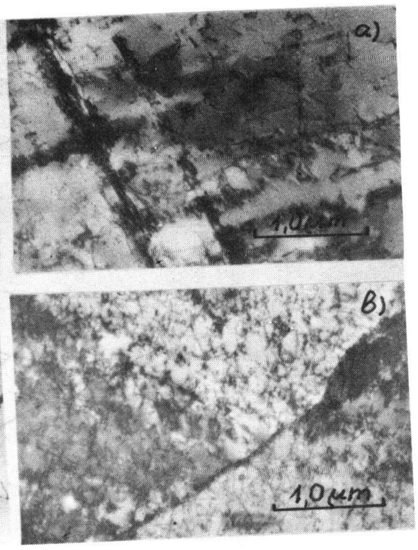

Fig.4. Impact-fractured specimen A with 0 % N
a) -120°C b) -196°C

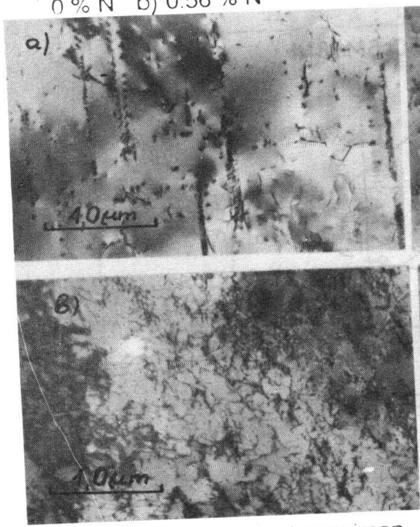

Fig.5. Impact-fractured specimen B with 0.28 % N
a) -80°C b)-196°C

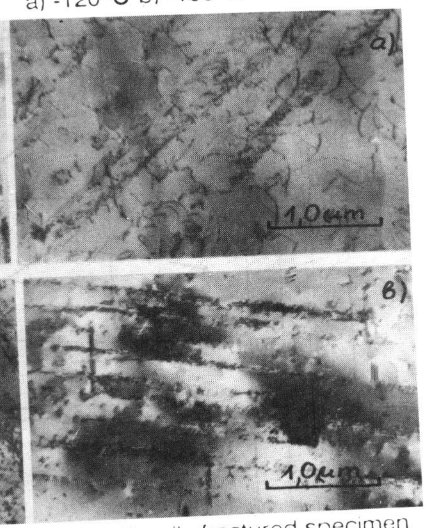

Fig.6. Tensile fractured specimen at -196°C
a) A / 0.64 % N b) B / 0.48 % N