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STRUCTURAL SUPER-HIGH PLASTICITY OF STEELS

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Annotation: This chapter discusses the significant enhancement of steel plasticity when transformed into a hollow state, with a focus on structural superplasticity. It examines the behavior of microstructured steels with ultrafine grains at elevated temperatures and explores the influence of phase transitions, carbon content, and alloying elements on the microstructure. Particular attention is given to the deformation behavior of technically pure iron during heating and phase changes.

Keywords: Steel plasticity, superplasticity, microstructure, phase transition, pure iron, ferrite, austenite, deformation temperature

Technical pure iron plasticity anomaly

It is possible to dramatically increase the plasticity of steel by transferring it to a hollow state. In this chapter, the structural superclasticity of Steel is considered. Due to the fact that OYUPD is observed at temperatures above 0.4-0.5 Tpl, it will be necessary to consider the possibility of obtaining microstructured steel with ultra-small grains at these temperatures. In steels, both Matrix and microduplex microstructure can be formed due to the polymorphism of iron, as well as due to the large dependence of the microstructure and phase composition on the amount of carbon, the amount of elements that legitimize and the heating temperature. When heated, the microstructure of steels can change greatly as a result of phase changes. In the field of one phase or another, respectively, it is better to start observing the etching deformation from iron-carbon alloys [13].

Of interest is primarily the technical consideration of the plasticity of pure iron depending on the deformation temperature and its association with changes in phase and microstructure in heating. When iron is heated, ferrite grains become unstable, growth occurs violently. At temperatures corresponding to critical iron points, the microstructure of iron is large-grained. More high extensions in technical pure iron [10] are observed at temperatures close to the temperature at which the change begins, as noted in the work. In the field of Phase rotations of technical pure iron with a content of 0.006% s, the α"γ elongation increases significantly as the αγ approaches the temperature at which the rotation begins, reaching a maximum (50%) at the highest temperature where the single – phase State (ferrite) is present at 850 S. When switching to austenite-ferrite domain, the occurrence of austenite leads to a sharp decrease in elongation by up to 5%. In the austenite area, the elongation increases with increasing temperature and is 30% at 1000 C [3].

The tensile stress increases monotonically as the deformation temperature increases. In the area of Phase Change, an increase in the voltage of the current is noted in one micror. In the field of phase change, the nature of the temperature Binding of the relative elongation of iron is very close to the temperature Binding of the technical pure titanium plasticity seen above. Such a case can be explained from the assumption of differences in the deformation descriptions of the phases of Super-highiplastic Ferrite and less plastic austenite [10]. However, no data has been cited on the exact structure that supports this assumption.

The data considered on the plasticity of iron in the phase change interval [4] is not consistent with the results of the work.

The authors show that iron containing 0.017% S in the range of polymorphic growth temperatures has higher values of m (0.6) and δ (≥≥150%). But [9, 10] there is no way to determine the cause of differences in data due to the lack of structural studies in the works.

An increase in carbon content and the consequent separation of cementite in steel should have a stabilizing effect on the microstructure. The OEUP symptoms found when testing a 50% cold spread steel with a content of 0.05% S for displacement indirectly confirm this [4].

When heating at a deformation temperature (540 C), an equal-axis microstructure with a grain size of 5-7 μm is formed in steel. At the same temperature and 5-10 MPa loadings, a uniform relative elongation of up to 80% was observed, with values of σ strongly dependent on the magnitude of the applied force. The extension also began to decrease when the voltages decreased.

It should be noted that in the following years, many data [10,5] have appeared that confirm an increase in plasticity in the interval of phase changes from as1 to AS2. Other confirmed and experimentally proven [9, 8] opinions that plasticity does not increase in the interval of opposite AS1-AS2 phase changes, but decreases rather, have also been.

Such contradictions are largely due to the fact that it is much more difficult to systematically study the mechanical properties of iron at the time of phase change, especially its microstructure. Therefore, the study of plasticity in technical pure iron at different deformation temperatures and especially in the field of Phase Rotation is one of the pressing issues [11].

Mechanical properties were studied in the tt11141 model machine of the firm" Instron " in the range of deformation speeds of 500-950 S of temperature and 10-4-10-2 s-1. Samples were used with a 5 mm diameter of the working part and a 25 mm base. The heating of the samples to the temperature of the tests was carried out in a three-SEC resistance furnace, in which the temperature gradient did not exceed ±5 C at a length of 300 mm

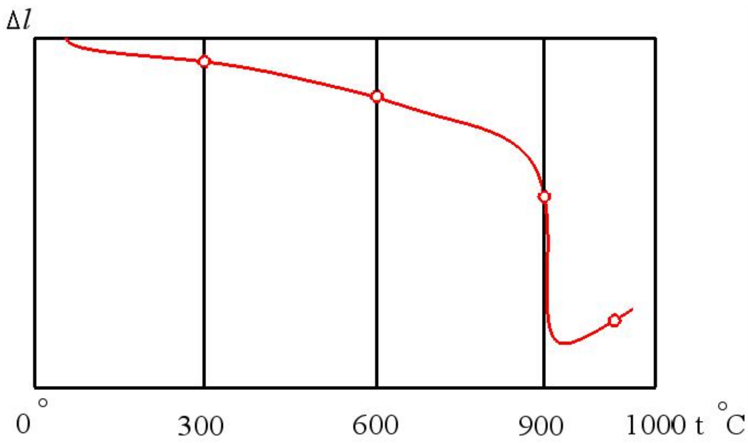
Before deformation, the samples were kept in the oven for 20 min in an attempt to heat up and ensure that the given temperature stabilizes. To reduce the oxidation of samples at high temperatures (600-700 c), EVT13 protective glass enamel was applied, which was applied to the working part of the sample before heating.

Metallographic studies have been conducted on" NEOPHOT21 " optical microscopy. The temperature of the α→γ phase change in pure iron with a given composition has been determined by differential dilatometric analysis in the "CHEVEHARD" device at a rate of 40C (figure 1.1), in which the polymorphic rotation has been found to occur at a temperature range of 900-920 C.

The rotation interval noted above is explained by the action of mixtures, mainly silicon, which expands the polymorphic rotation interval of iron.

Technical pure iron was observed to contain a – α-phase at temperatures below 900 C, and a – γ phase at temperatures above 920 C.

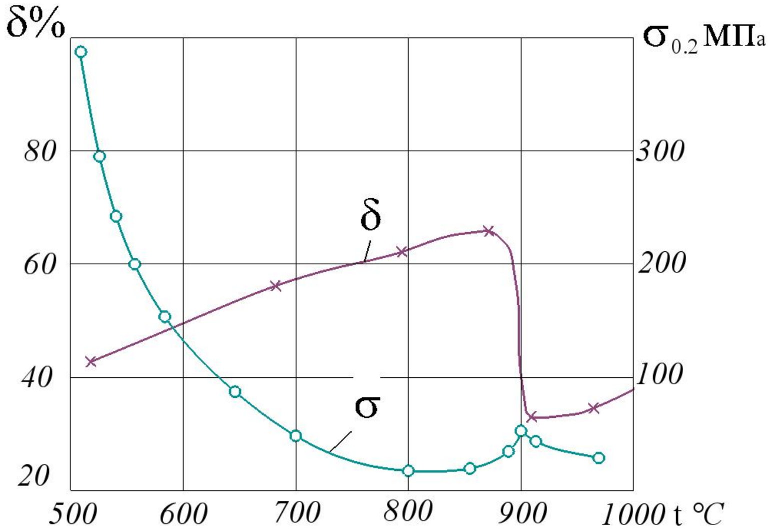
Stretching tests were carried out on the dynamometer of the firm" Instron " at a temperature range from room temperature to 1000 C, that is, mainly in the α-field and partially in the γ-field. The heating temperature was controlled by chromel-alumel thermocouple with an accuracy of ±3 C.



1.1 picture. Technical pure iron heating dilatometric curve

The heating rate was 40 C / min. The sample heating time is 25 min. Deformation rate ἐ=6.6·10-4C-1. Figure 3.2 presents The Binding of technical pure iron to deformation temperature in the delivery state of δ relative elongation, with an increase in temperature there is a continuous increase in δ (from 44% at 500 C to 64% at 870 C), with a further increase in temperature it has a sharp decrease in the area of phase transition and then a significant increase in

The dependence of the current voltage on temperature is also of a non-monotonic nature. Figure 1.2 shows that further increasing the test temperature dramatically reduces the leakage voltage, but σ increases significantly again near the α → γ rotational temperature domain. However, the greatest interest is thought to determine the causes of a sharp drop in plasticity when the phase cycle temperature is reached.



1.2 picture. Temperature dependence of δ relative elongation at $\dot{\varepsilon}$ = 6.6·10-4C-1 in technical pure iron

Figure 1.3. Deformation relief occurring at a temperature of 870 C is 500 x

For this reason, microstructure has been studied, as well as the deformation relief that occurs in deformation. As can be seen from figure 1.3, the deformation relief of technical pure iron, from which the deformation mechanism differs significantly at these temperatures.

No slip bands were detected in the deformation. At the same time, at a temperature of 870 c, another characteristic phenomenon was found – the development of the separation of grains into pieces (figure 1.3).

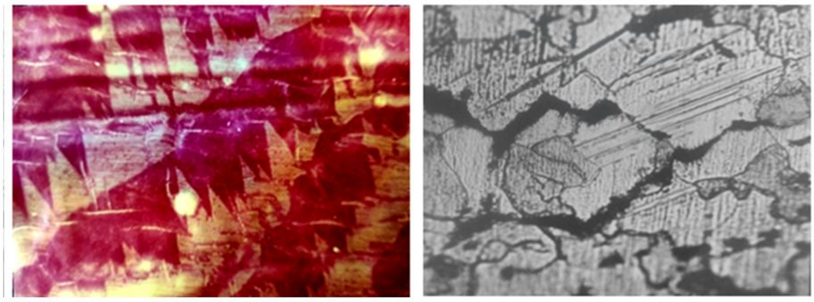
At a deformation temperature of 910 c, another deformation relief is observed (1.5, a-figure). Under these conditions, slippage increases sharply, in some individual grains there is a development of characteristic relief and transcrystalline decay in the microenterprise, the development of which, apparently, leads to a decrease in the plasticity and decay of technical iron (1.5, b-figure).

а)

б)

в)

Figure 1.4. The appearance of samples after stretching at different temperatures in the initial sample state:



а) б)

Figure 1.5. The deformation relief determined by the method of oxidation of the metallographic glyph in vacuum at temperatures 910 C (a) and 910 C (b) is 1500 x

Deformation is localized in the areas of the boundary, which leads to the formation of microwaves and a decrease in iron plasticity.

The deformation relief at 940 C is complicated by changes in microstructures in reverse phase shift (figure 1.6). The results obtained make it possible to predict the causes of a sharp drop in the plasticity of technical pure iron near the phase transition point. In deformation, the probability of plate formation $\alpha \rightarrow \gamma$ binds to the sliding character of the rotation [12].

Figure 1.6. Deformation relief at 940 C temperature 500X

It has been found that the technique binds the plasticity of pure iron non-monotone to the deformation temperature. in the field of α→γ phase transition, a sharp drop in plasticity is observed, which apparently binds to the sliding character of α→γ rotation. This is considered an obstacle to the movement of dislocations, and intercrystallite leads to decay.

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