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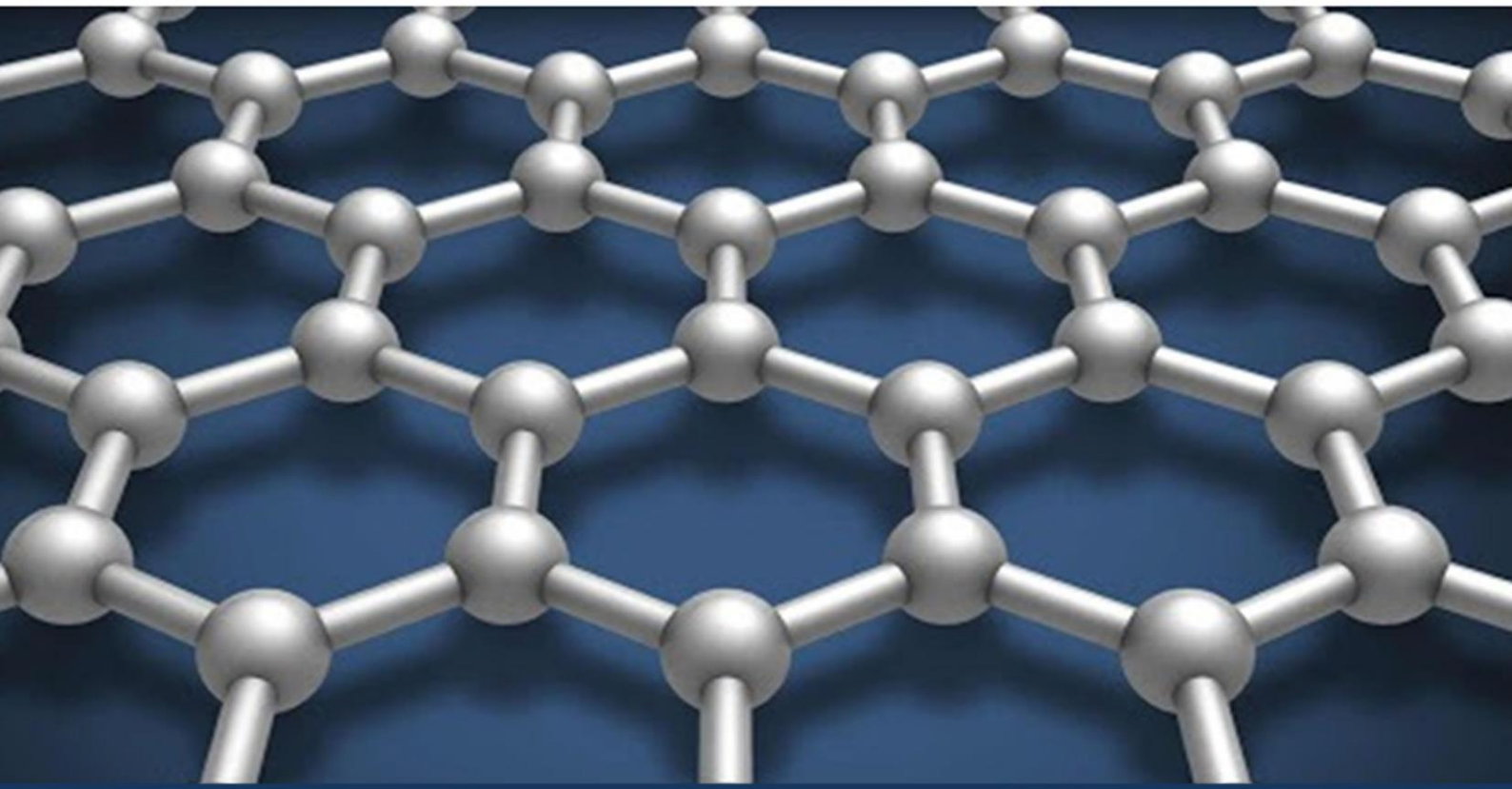

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STUDY OF THE STATE OF THE STEEL SURFACE AT THE INTERFACE BETWEEN METAL AND SCALE DURING HEATING

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Annotation. In this article, the state of the boundary surface between soot and metal is considered. The main factors in the occurrence of rolling defects and the removal of soot cructs from the steel before heat deformation.

Key words: alloying, scale, phase, hydrobeating, workpiece.

When heated, the surface of the steel oxidizes and becomes covered with a layer of scale. Metal oxidation during heating is a process of two-way diffusion, involving chemical reactions between oxidizing gases with iron, alloying elements and impurities from the surface of the formed scale layer inward through this layer and in the opposite direction.

In cases where the penetration of oxides into the metal along the grain boundaries is absent or very insignificant and there is a clear boundary between the steel and the scale (Fig. 1), during hydrablosting and plastic deformation, scale removal occurs without any sicnificant difficulties, and the separation surface is quite smooth.

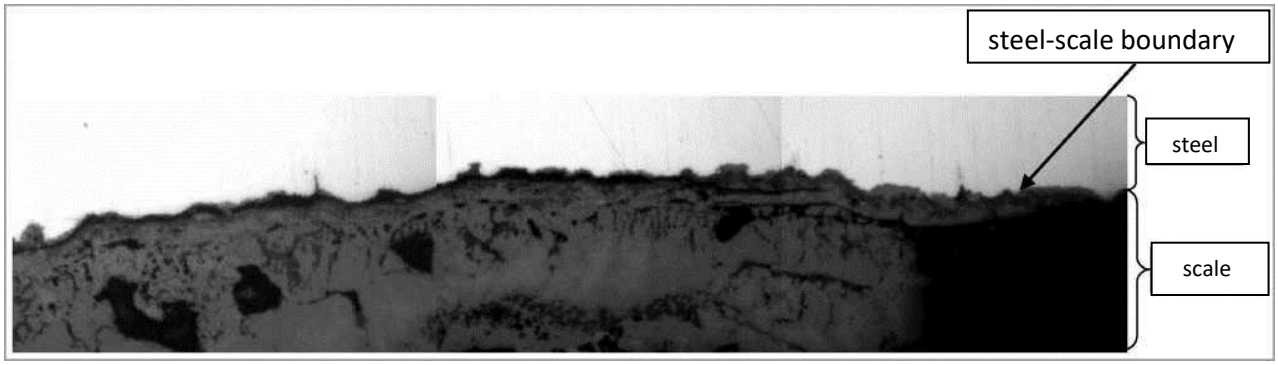

Fig. 1. Clear boundary between steel and scale on a sample of a workpiece after heating for rolling according to the corresponding mode. ×500

The most intense indentation of scale, the formation of pits and speckles are observed in cases where the scale hardness is higher than the metal hardness. In the deformation zone, the scale cools rapidly and cracks. As it cools, it becomes harder and is pressed into the adjacent metal layers. During high-temperature oxidation of alloy steel, a small portion of the alloying elements passes into the scale. The presence of such elements as Cr and Mn in the scale also contributes to an increase in the scale hardness.

When heating steel in a reducing atmosphere with an oxidizer consumption coefficient < 1, the resulting dense scale is removed much more difficult to remove and increases the likelihood of the rolled-in scale and pitting defects

The appearance of a liquid phase in the scale is highly undesirable, accompanied by ionization of the grain boundaries of the steel, penetration of scale between them, intensive growth of the mixed zone (scale metal) and, as a result, its adhesion strength to the metal increases.

A fragment of a workpiece was examined after heating in a furnace with a violation of the regime excessively high temperature and prolonged heating, on the surface of which, after passing through a water-scaling unit , a significant amount of so-called “sticky scale” (Fig. .2, *a)* and areas of molten scale (Fig. 2, b) remained , having a strong bond with the metal surface.

a *b*

Fig. 2. Surface of the workpiece after hydroscaling: *a* - with unremoved scale; *b* - areas of molten scale

In the area with unremoved scale, the surface was examined using an optical microscope. The examination revealed that between the scale and the metal there was a layer of so-called "sticky" scale due to the penetration of oxides deep into the metal along the grain boundaries; there was no clear scale-metal dividing line at all (Fig. 3).

Compliance with the heating technology (absence of overheating of steel and melting of scale) made it possible to prevent the formation of “sticky scale” and reduce the adhesion of scale to the surface of the metal, which significantly improved the conditions for removing scale from the surface of the workpiece in the hydros slag unit before hot deformation.

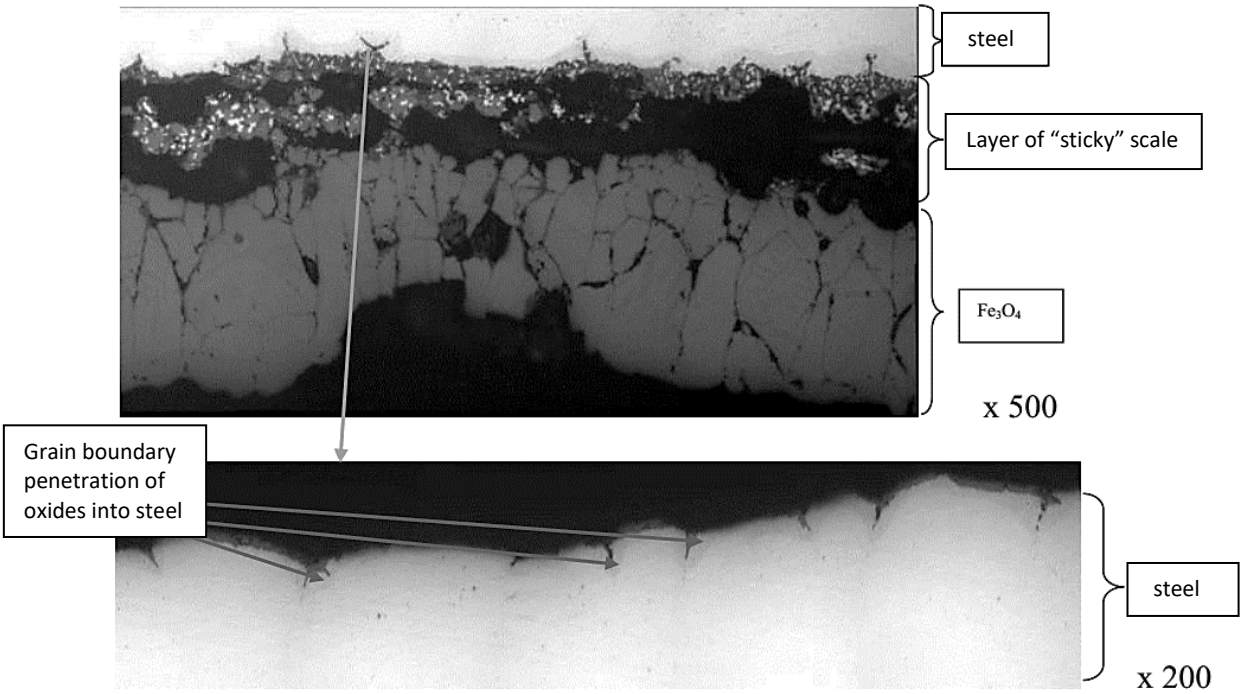

Fig. 3. Surface scale in the cross-section of a microsection of a workpiece that was not removed after passing through a descaling unit.

Conclusion. The main influence on the formation of rolling defects such as “rolled-in scale”, “speckled” and scale cavities is exerted by the quality of the removal of furnace scale from the surface of the workpiece before hot deformation.

If the hydroscaling unit operates unsatisfactorily, or if the hydroscaling unit operates satisfactorily but the heating mode of the workpiece is not observed before deformation and hard to remove so-called “sticky” scale is obtained, incomplete removal of scale occurs, which subsequently leads to mass sorting of rolled products according to surface defects such as “rolled-in scale”, “dimples” and scale cavities.

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