PRIVATE ATOMS IN METALS

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Abstract: This article presents about metals and its private atoms.
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Introduction: Historically, man had a limited number of fundamental physical influences at his disposal, which underlie the processing of materials in order to improve their structure and properties, to change their shape, etc.

The effect of temperature is at the heart of the heat treatment of materials. The impact of pressure is the basis of forging, rolling, stamping, etc. Many types of surface modification and treatment are based on the impact of flows of micro- and macroparticles: implantation, special coatings, etc. By acting on physical fields, it is also possible to control the structure and properties of materials.

Methods: In the last quarter of the 20th century, it was firmly realized that the effect of hydrogen on materials is as fundamental as the effect of temperature, pressure, physical fields, and flows of micro- and macroparticles. A number of fundamental phenomena and effects were discovered, which greatly expanded our knowledge of the hydrogen action on materials. At the same time, there was an accumulation of knowledge about the technical methods of using hydrogen in the processing of certain materials. As a result, it would not be an exaggeration to say that in recent decades a new area of materials science and engineering has arisen - hydrogen processing of materials, which is now developing quite intensively all over the world.

Hydrogen processing, as a new area of materials science and technology, sets itself technical goals and objectives in two directions. The first is the technological direction. One challenge here is that hydrogen is being used to improve existing technologies for producing and processing materials. Another task is to develop fundamentally new hydrogen technologies, which are generally impossible without the use of hydrogen. For example, it is impossible to strengthen metals and alloys that do not have polymorphism without changing their size and shape. After the discovery of the phenomenon of hydrogen-phase hardening, such a technology became possible through hydrogen treatment based on this phenomenon. Another example: it was impossible to convert a solid crystalline substance into an amorphous state at low temperatures. After the discovery of hydrogen amorphization, such technologies became feasible, and they are completely based on the effect of hydrogen on materials. Another technical direction of hydrogen processing includes tasks to achieve the required end results. If, at the final stage of the PTO, hydrogen is completely evacuated from the processed material, then as a result, after processing is completed, we have the original material in a new, changed state with improved structure and properties. So, the achieved goal of the PTO in this case is to improve the structure and service properties of the material without changing its chemical composition with respect to hydrogen. For example, types of PTOs are known, where hardening of the metal, grinding of grain and structural components, improvement of magnetic properties, etc., etc. are achieved.

If, at the final stage of the PTO, hydrogen is not evacuated from the material or is only partially evacuated, then as a result, after completion of processing, we have a fundamentally new hydrogen-containing material with a structure and properties unattainable by any other means. Here, for example, such types of PTO are known that make it possible to obtain high-strength palladium-hydrogen alloys with a hydride TRIP effect, vanadium-hydrogen alloys with a shape memory effect, hardened niobium-hydrogen alloys, etc.

Thus, PTO, being an applied science, allows achieving a whole range of technical goals: on the one hand, to improve existing and develop new technologies to improve the structure and properties of materials, and on the other hand, to obtain new hydrogen-containing materials with unique properties.

Results and Discussion: Hydrogen processing of materials, firstly, is based on the special properties of the hydrogen atom as such, and, secondly, on the features and properties of the hydrogen 'atom' embedded in the crystal lattice of a solid. Accordingly, the hydrogen impact on materials underlying the PTO is also characterized by unique features: it is a controlled and extremely strong external impact on materials. This effect is reversible in the sense that hydrogen can be evacuated from the material down to very low temperatures. Hydrogen action on materials includes physical, chemical, physicochemical and mechanical components.

The physical component of the hydrogen effect is manifested in a change in the electronic structure of the material, in possible changes in the phonon spectrum of the crystal lattice and the hydrogen subsystem, in an increase in the equilibrium concentration of vacancies and, accordingly, in the diffusion mobility of substitution and interstitial atoms, in the interaction of hydrogen with crystal defects and in changes in their stability and mobility , etc.

The chemical component of the hydrogen action is due, in particular, to the fact that hydrogen is a very strong chemical reducing agent and a very active reagent, which makes it possible to modify the surface layers of the material and its special coatings, act on bulk structural components, conduct indirect doping of the matrix due to reactions with oxides, carbides and other chemical compounds introduced into the material or in contact with it.

The physicochemical component of the hydrogen action is that the hydrogen action leads to a violation of the thermodynamic conditions for the existence of both the material itself as a whole and its individual phases. As a result, there is a thermodynamic need for hydrogen-induced phase transformations. This is the so-called 'artificial', hydrogen-induced polymorphism.

In polymorphic materials, the thermodynamic conditions for the realization of natural polymorphism change, as a result of which some phases stabilize and expand their area of existence, critical points, the mechanism and kinetics of phase transitions, the morphology and chemical composition of the transformation products change.

Due to the different affinity of hydrogen with individual atoms - the components of the material and its individual phases - there is a thermodynamic necessity for phase transformations of various types. As a result, the material decomposes into separate phases or even separate parts that have different affinities for hydrogen, etc., etc.

The mechanical component of the hydrogen effect is due to the fact that hydrogen dissolved in the material causes a strong dilatation of the crystal lattice. Accordingly, any of its inhomogeneities and redistributions, any gradients of its concentration, due to external or internal causes, cause the appearance of internal mechanical 'hydrogen' stresses.

Conclusion: Hydrogen processing of materials, being a new area of materials science, includes two branches: PTO theory and PTO technology. For the successful development of the theory of PTO, it is necessary to pay more and more attention to the diffusion-cooperative nature of material-hydrogen systems, to the formation on this basis of the first principles of PTO.

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