STUDY OF ELECTRONIC PROPERTIES OF TRANSITION METALS AND ALLOYS BY POSITRON ANNIHILATION SPECTROSCOPY

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We have analyzed a number of data on the electronic properties of the pure metals [1][http://zldm.ru/upload/iblock/53b/20097506027.pdf]. For transition metals there is a clear correlation between the melting point and the number of unpaired *d*-electrons. We think that the unpaired *d*-electrons characterize the tendency of metals to the formation of covalent bonds, which are stronger than metallic bonds. This process of formation of such bonds is likely activation character. These properties and determine the increase of the melting point with increasing the number of unpaired electrons *d*-electrons. These effects may also explain the presence of possible modified ductile-brittle transition - type Ioffe in structural materials (metals and alloys) under irradiation with neutrons at elevated temperatures. The temperature of the brittle-ductile transition Ioffe sensitive to impurity content) and the structure of the material. Especially important is the brittle fracture in those cases when it occurs at sufficiently high temperatures (room temperature and above). Indeed irradiation by neutrons of metals and alloys at temperatures of less than $0.3T_m$, wherein T_m - the melting point, increases its strength due to the formation of radiation damage and defects, which are an obstacle to the movement of dislocations, but in this case the radiation substantially, and in large doses drastically worsens their deformation and plastic properties . This circumstance (radiation embrittlement) limits the service life of many alloys used in nuclear power: with increasing radiation dose sensitivity to impact alloys increases.In our experiments with the reactor steels it has been found that the concentration of electrons in the conduction band decreases with increasing neutron fluence. We have entered value

$$\alpha_k \approx \frac{n(\text{irrad}) - n(\text{rad})}{n(\text{irrad})},$$

characterizing the degree of covalent chemical bonds. Here $n(\text{irrad})$ – concentration of electrons in the conduction band in the irradiated metal, and $n(\text{rad})$ – concentration of electrons in the conduction band of irradiated metal. Based on the experimental data: $n(\text{irrad})=11.9\cdot10^{22}\,\text{cm}^{-3}$, $n(\text{rad})=9\cdot10^{22}\,\text{cm}^{-3}$. Hence the degree of covalence of the chemical bond is the value of $\alpha_k \approx 0.25$. The research vessel steels used in operating reactors VVER- 440. In the samples studied steels identified vacancy defects, including those caused by neutron irradiation, and are defined by their size.

1. В.И.Графутин, Е.П.Прокопьев, С.П.Тимошенко и др. // Заводская лаборатория. Диагностика материалов. 2009. Т.75. С.27; http://zldm.ru/upload/iblock/53b/20097506027.pdf