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Hydrogen diffusivity and solubility in $Pd_{0.97}Zr_{0.03}$ alloy

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Abstract – The $Pd_{0.97}Zr_{0.03}$ alloy was produced and studied in the present work as respect the hydrogen diffusivity and solubility. These alloys in the conditions as melted and cold worked, heat treated and also internally oxidized were submitted to hydrogen permeation tests. It was observed that the hydrogen diffusivity is strongly affected for the internally oxidation due to nano-oxides formation.

When small amounts of metallic alloying elements, which interact strongly with oxygen, such as Al, Zr, Ce, Cu and Cr, are inserted into the matrix of noble metals or alloys, such as Pd and Ag, it is possible to perform treatments to obtain ceramic-metal composite materials [1]. The duration and the temperature of the heat treatment to promote internal oxidation are important factors in the formation and final morphology of the oxide precipitates, which, in turn significantly influence the physical and chemical properties of the materials, such as hydrogen diffusivity and solubility. This is due to the creation of news interfaces that trap the hydrogen in the sample [2]. The main of this work is to analyze the effect of internal oxidation on the hydrogen diffusivity and solubility in the Pd alloys with Zr by electrochemical permeation tests and TEM. This work shows the results of electrochemical hydrogen permeation tests in the samples of $Pd_{0.97}Zr_{0.03}$ in the conditions: cold worked and internally oxidized in different temperatures which result of nanosize precipitate oxides in the Pd matrix (figure 1 and 2). The shape and size of the precipitates and the coherence between precipitates and matrix was observed by transmission electron microscopy (TEM). It was observed, by the electrochemical hydrogen permeation tests, that the presences of oxides increase the apparent hydrogen solubility, S_{app}, but the diffusivity, D_{app}, decrease (table1). The interaction of hydrogen with precipitates as well as nature, size and distribution of the precipitates in the hydrogen permeation parameters are discussed in this work.

Table 1: Hydrogen diffusivity and solubility in the $Pd_{0.97}Zr_{0.03}$ alloy at 298 K.

Alloys	D_{app} ($m^2.s^{-1}$)	S_{app} (mol H m^{-3})
$Pd_{0.97}Zr_{0.03}$ Cold work	1.1×10^{-11}	2081
$Pd_{0.97}Zr_{0.03}$ HT 1073 K – 24 h	0.3×10^{-11}	5228
$Pd_{0.97}Zr_{0.03}$ HT 1273 K – 24 h	0.7×10^{-11}	3701

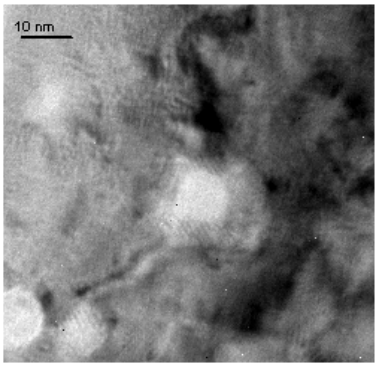

Figure 1: $Pd_{0.97}Zr_{0.03}$ alloy heat treated at 1073K for 24h.

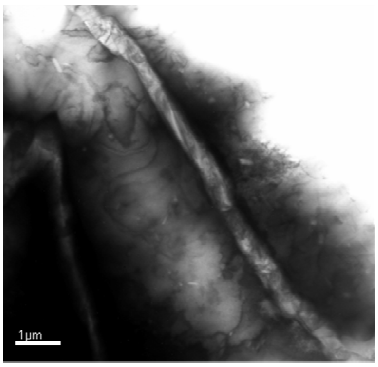

Figure 2: $Pd_{0.97}Zr_{0.03}$ alloy heat treated at 1273K for 24h.

References

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