Physical Effects Due to Hydrogen

PROGRESS IN HYDROGEN TREATMENT OF MATERIALS

EDITED BY V. A. GOLTSOV, Donetsk-Coral Gables: Kassiopeya, Donetsk, 2001, 543 pages, ISBN 966-7418-71-5, $99 (softback)

This compilation of papers on aspects of the hydrogen treatment of materials (HTM), contributed by well-known scientists from ten countries, brings together information on a wide range of hydrogen-induced physical effects on metals, alloys and compound systems. Professor V. A. Goltsov, whose interest in this topic goes back for many years, reviews the status and development of this field of materials science and engineering, begun some 25 years ago, and now of increasing importance due to the rapid commercialisation of fuel cell technology and the growing need for a clean and renewable economy, not forgetting, of course, the traditional and important aspects of hydrogen-induced corrosion.

Part I covers HTM theory, papers discuss topics such as fundamentals of hydrogen treatment of materials (V. A. Goltsov); thermodynamics of hydrogen solution in 'perfect' and defective metals and alloys (T. B. Flanagan): for instance, ordered Pd_3Mn alloys dissolve significantly more H_2 than the disordered form; diffusion and diffusive phenomena in interstitial subsystems of M-H systems (L. I. Smirnov and V. A. Goltsov); theory of the hydrogen elasticity phenomenon (V. A. Goltsov, T. A. Ryumshina, *et al.*); hydrogen in thin films and multilayers (H. Zabel and B. Hjorvarsson). In nanostructured metal films and superlattices, hydrogen has been used to 'tune' the epitaxial misfit to the substract for generating a modulated lattice gas and to switch optical and magnetic properties. Also covered are uphill hydrogen diffusion effects (F. A. Lewis); hydride transformations: nature, kinetics, morphology (M. V. Goltsova, Yu. A. Artemenko, *et al.*); hydride shape memory effects (L. S. Bushnev); the hydrogen-phase naklep phenomenon and its use in hydrogen treatment of metallic materials (V. A. Goltsov and N. N. Vlasenko).

In Part II, HTM technology is described. Reviews cover hydrogen effects of metal surface treatment (E. Lunarska), with hydrogen modifying the elastic, inelastic and plastic properties of the material surface. Other papers discuss the effects of hydrogen on titanium and its alloys and for casting aluminium alloys; the systematisation and peculiarities of hydride crystal structures forming under the interaction of hydrogen with intermetallics (S. Miraglia and D. Fruchart); hydrogen induced amorphisation of intermetallics (K. Aoki); hydrogen-induced diffusive phase transformations in $Nd_2Fe_{14}B$-type alloys (V. A. Goltsov, S. B. Rybalka, *et al.*); surface modifications of hydrogen storage alloys and their applications in recent hydrogen technology (H. Uchida); effects of hydrogen inclusion on the electrical properties of metal oxides and nitrides (Y. Hayashi and T. Ishikawa); and hydrogen treatment of non-metallic catalytic materials (L. Jalowiecki-Duhamel).

Part III looks at the degradation that hydrogen can cause, with reviews on hydrogen degradation of some hydride-forming metals and their alloys (A. Zielinski) and hydrogen in welding processes (I. K. Pokhodnya and V. I. Shvachko).

The Appendices contain thoughts on this new paradigm of materials science – from its beginnings and development (V. A. Goltsov; L. F Goltsova); and the hydrogen treatment of materials is classified (V. A. Goltsov).

Information is included on hydrogen interactions with palladium and palladium alloys, (Pd-Ag, Pd-Au, Pd-Al, Pd-Zr, Pd-Mg, Pd-Ni, Pd-Pt, Pd_3Mn, Pd_3Fe, Pd-Ce, Pd-Sn, Pd-Cu). For these materials, interest is focused on thermodynamic properties, a macroscopic reversible and non-reversible form-changing effect; Gorsky effect; Lewis effect; hydrogen-induced grains shift; hydrogen phase naklep (cold work); hydrogen failure; hydride transformations; hydrogen-induced ordering-disordering; diffusion; and hydrogen elasticity.

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