ANALYSIS OF HYDRIDE STRUCTURES AND PHASE TRANSFORMATIONS IN THE HYDROGEN -TITANIUM ALUMINIDES SYSTEMS

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Current concepts of the kinetics of interaction of hydrogen with the ordered intermetallic aluminides, Ti_3Al and TiAl, will be reviewed and the results will be analyzed in light of potential applications of these materials to effective hydrogen storage and in aerospace construction engineering.

The kinetics of direct reaction of powders of aluminum and titanium under non-equilibrium conditions of self-propagating, high temperature synthesis is investigated at the Institute for Problems of Materials Science. The chemical compounds TiAl and Ti_3Al are formed from appropriate powder mixtures in a single front propagation reaction at elevated temperatures, and also during volumetric combustion of powder environment. The quality of a single phase product is dependent upon controlling the speed of the reaction, purity of reactants (high vacuum outgassing and refinements from interstitial imputities), etc. The effects of the reaction parameters, advantages, economical aspects and productivity in producing heat resistant, high density intermetallics are analyzed using TiAl as an example.

New results of temperature measurements of electrical resistivity on hydrogen charged TiAl alloys have been obtained at the International Center of Electronic Materials Science and Applied Problems of Aerospace Technology. Observations in the temperature range 293-1073K indicated substantial difference between heating curves and cooling curves (hystheresis) and thermal unstability of TiAl/H caused by insufficient active bonding of hydrogen as compared to the gamma-Ti_3Al alloy. These observations are confirmed by paramagnetic susceptibility and differential thermal analysis data. Hydrogen embrittlement of the non-equilibrium structures result from matrix cleavage, and fracture along an interphase of surface enriched with hydrogen and an ordered matrix. The process is adequately described by a model of delayed fracture taking into account thermally activated and athermal contributions of interaction of hydrogen with an ordered matrix. It is assumed that the hydrogen embrittlement of polycrystalline is not an intrinsic property of the TiAl structure. Structural studies of hydride phases in the Ti_3Al/H system have continued at the Institutt for energiteknikk. X -ray and neutron diffraction analysis of hydrides formed in this system and the consequent reduction in mechanical stability will be reported.

References

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