

KINETICS OF NICKEL HYDRIDE FORMATION AT HIGH PRESSURE OF GASEOUS HYDROGEN

A. Stroka, B. Baranowski

Institute of Physical Chemistry, Polish Academy of Sciences,
ul. Kasprzaka 44/52, 01-224 Warsaw, Poland

Introduction

Kinetics of nickel hydride formation was, so far, investigated during electrochemical preparation of this phase on Ni wires [1] or in high pressure gaseous hydrogen for nickel powder [2]. In the first case the well known parabolic law was found [1], in the second [2] the logarithmic time dependence represents the kinetics near the absorption plateau in gaseous hydrogen. Recently we investigated the kinetics of hydride formation on Ni foils in high pressure of gaseous hydrogen, starting from not previously treated samples.

Results and discussion

Nickel Hydride formation was followed by electrical resistance measurements, applying the four pole technique. Fig. 1 presents an example of the time course of the relative electrical resistance as a function of square root of time of a nickel foil. 4 consecutive periods can be distinguished.

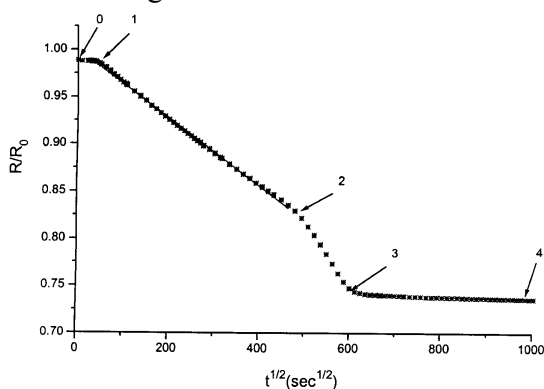


Fig.1. The relative electrical resistance of a 13x1.5 mm x 50 μ m Ni foil as a function of square root of exposition time to 14.1 kbar of gaseous hydrogen at 25⁰ C.

1.) 0-1 represents the induction period, caused by the surface activation and saturation of the

bulk nickel by penetrating hydrogen up to the upper limit of the α -phase of the Ni-H system.

2.) Part 1-2 involves the longest time period, fulfilling the well known parabolic law of phase transition, in this case the formation of nickel hydride. It involves about 17 μ (from both sides of the foil) being transformed into the hydride phase, that is about 2/3 of the nickel available.

3.) Part 2-3 represents an „accelerated” formation period, which covers the rest of the unreacted nickel available. This unexpected acceleration can be explained by the reduction of the strained part of the unreacted internal nickel layer, characteristic for the final penetration (from both sides). [3]. Thus, the approach of the hydride fronts is characterized by a higher formation kinetics.

4.) Part 3-4 represents the stationary state after the previous two approaching hydride fronts coincided.

Conclusions

The kinetics of nickel hydride formation follows - after an inhibition period - the parabolic law, well known in solid state phase formation kinetics. The final step of hydride phase approach of opposite fronts is characterized by an acceleration.

References

- 1.) B. Baranowski, Bull. Acad. Polon. Sci., 7, 907 (1959).
- 2.) B. Baranowski, M. Tkacz, Z. Phys. Chem. (N.F), 163, 457 (1989).
- 3.) A. Stroka and B. Baranowski, Polish J. Chem., 77, 481 (2003).