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New Experiments on Pressure Hysteresis in $LaNi_5$-H_x*

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We report here a series of experiments in which parameters such as the measurement time, H aliquot size and degree of thermal isolation of the sample are systematically varied. The hysteresis of a well-cycled sample trends down to a steady value for cycle times longer than a few days, even when viewed on a logarithmic time scale, suggesting that the absorption plateau should the thought of as a sequence of local energy minima corresponding to metastable equilibrium states. The same conclusion has been drawn from experiments in which very small pressure excursions are used to drive the metal hydride into the region between the absorption and desorption plateaux, where linear, reversible behaviour is found. We have also studied the absorption of large versus small aliquots of H, and are currently investigating the effects of the temperature rise during absorption. The reduction of hysteresis achieved by increasing the defect concentration appears to far outweigh any increase in hysteresis due to the energy lost in their creation.

1. Introduction

The occurrence of pressure hysteresis in metal hydrides can be plausibly explained by defect creation causing irreversible energy loss [1, 2, 3], or by H-H interactions, which in a mean-field model can cause bistability, i.e. distinct α and β phases separated by a miscibility gap [4, 5, 6]. We are studying pressure hysteresis in $LaNi_5H_x$ with the intention of determining its fundamental cause(s), and report here on the results to date.

2. Experiments

Hysteresis loops in the pressure-composition plane were executed using a computer-controlled Sartorius 4406 microbalance and two manometric hydrogenators, of which one is attached to an X-ray diffractometer with a pressurizable sample chamber. We have studied the response of the hydrogen-to-metal ratio (H/M) to pressure changes from a few Pa to hundreds of kPa, on time scales from seconds to 10 days.

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