EFFECT OF NANOSTRUCTURING ON THE HYDROGEN STORAGE PROPERTIES OF *$LaNi_5$* SYSTEMS

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Pressure–composition isotherms of $LaNi_5$ alloys were studied as function of ball-milling time. Results indicate a strong hindrance to the hydrogenation of the long-time ball-milled samples. Local structural studies reveal that the nanostructured powders are characterised by reduced unit cell volume and enhanced atomic disorder. Results of the X-ray diffraction and differential scanning calorimetry are in agreement with the results of the local structure studies.

Introduction

Nanostructuring using ball-milling is found to be very effective in improving the hydrogen sorption kinetics of materials like Mg [1]. However, such a ball-milling induced nanostructuring is found to have an adverse effect on the hydrogen sorption properties of the conventional hydrogen storage material, $LaNi_5$ [2]. We have studied the above system using a number of experimental techniques - a brief summary of the results are presented.

Experimental

Ball-milling of the $LaNi_5$ powders, with varying milling times, were performed using a Fritsch miller. Some of the milled samples were annealed under high vacuum. Hydrogen sorption properties of these samples were studied by measuring the pressure-composition isotherms (PCIs) at 35℃ using an automated Sievert's equipment. Local structure of these samples were studied using the Ni K-edge extended x-ray absorption fine structure (EXAFS). Differential scanning calorimetry (DSC) and x-ray diffraction (XRD) were also utilised for the characterization of the samples.

Results

With increase in milling time, PCIs showed an increase in the plateau-pressure and a reduction in the hydrogen capacity at pressures below 20 bar [2]. DSC measurements indicated an increase in the defect density with milling time. Observed enhancement in the H_2 intake in the initial part of the PCIs can be explained considering the milling induced particle size reduction and increase in surface defects. XRD results reveal that the long-time milled samples have identical crystal phase as that of the un-milled, but with slightly reduced lattice parameters and drastically reduced average crystallite sizes [3]. EXAFS results revealed a reduction in the near-neighbour (NN) distances in the long time ball-milled samples. In addition, a large increase in the atomic disorder was evident (as seen from the large mean square relative displacements (MSRDs) of the NN distances) [4]. Interestingly, in the long-time ball-milled samples, annealing is found to be have little effects in bringing back the atomic order [4]. Decrease in the NN distances and the corresponding increase in the MSRDs may be causing a higher energy barrier for the hydride phase formation in the long time milled powders.

References

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