

Hydrogen absorption effects on the physical properties of ball-milled LaNiSn intermetallic compounds

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A polycrystalline samples were prepared by arc melting high-purity elements under argon atmosphere. The samples were re-melted several times to ensure homogeneity. After arc-melting, the samples were annealed in vacuum at 800°C for 28h. After that, some samples were milled using a Ball milling technique. The hydrogenation was carried out by the Sievert's method using a high purity hydrogen gas. X-ray diffraction (XRD) measurements indicate the formation of the TiNiSi-type orthorhombic structure with space group Pnma for the unmilled sample and its hydride. The milled samples show broad peaks and poor crystallinity hindering the analysis of the structural properties. One sample was milled with 10wt% of graphite. The analysis of the graphite-milled sample reveals that graphite preserves the structural properties (the sample shows better crystalline quality) and acts as a catalyst for the absorption of hydrogen. The analyses of the XRD patterns show that the structural parameters are modified after the hydrogenation. The transmission electron microscope images corroborate the XRD data. Mössbauer spectra (297K) of the unmilled LaNiSn show the presence of only one doublet inconsistency with the one symmetry site of Sn atoms in the TiNiSn-type structure. Moreover, spectra of the milled samples are better reproduced by considering three doublets. Those components were associated with Sn atoms occupying regular sites (D1), Sn atoms substituting Ni atoms (D2) and Sn atoms of some spurious phase or Sn atoms localized in the interface region of the grains (D3). The spectral area of the D1 component decreases at expenses of the other two components. However, the isomeric shift (IS) of D1 and D2 shows a constant value as the milling time is increased. The IS of the third doublet shows some fluctuating behavior likely related to its small spectral area. The quadrupole splitting (QS) of D2 component shows larger value than that of the D1 component and both show clear increasing tendency as the milling time is increased. After the hydrogenation, the IS shows an increase related to the samples before hydrogenation. However, the IS of the D1 and D2 components do not undergo a drastic change in value with the milling time. The value of the QS of D1 and D2 components show an increase with the milling time. This result has been assigned to the indirect interaction between Sn and H atoms which causes an asymmetric electron distribution around the Sn atoms.