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Unlocking the metastable phases and mechanisms in the dehydrogenation process of titanium hydride

Abstract

There are many advantages of using titanium hydride (TiH_2) as a starting material for the fabrication of titanium products. However, a thorough understanding of the dehydrogenation process in the fabrication is crucial to ensure the high quality of the Ti components to be produced. In this work the phase transformations sequence during the dehydrogenation of TiH_2 powder to titanium have been investigated in detail using thermal analysis, high temperature XRD and Rietveld refinement. With the application of Rietveld refinement, the cell parameters and phase changes have been accurately determined, and the results reveal that the dehydrogenation of TiH_2 to Ti consists of several steps and involves a few previously unreported metastable phases and the equilibrium phases. The metastable phases actually possess the same crystal structures as those of the equilibrium phases, but with different lattice parameters. Under some conditions the metastable phases will be retained at ambient temperature. These metastable phases have been confirmed by transmission electron microscopy (TEM) and selected area electron diffraction (SAED). A step-transition mechanism has been proposed to explain the transformation process. This study will be useful for the fabrication of titanium-based composites and titanium alloys from TiH_2 powder.

Keywords

Dehydrogenation; Metastable phases; Rietveld refinement; Titanium hydride