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Author: Dr. Shumpei Ozawa
University of Tokyo, Hino, Japan, shumpei.ozawa@tmit.ac.jp

Dr. Satoshi Hirosawa
Research and Development Center, NEOMAX Co., Ltd, Osaka, Japan,
HIROSAWA.S@neomax.co.jp
Dr. Kazuhiko Kuribayashi
Japan Aerospace Exploration Agency (JAXA) / ISAS, Sagamihara, Japan,
kuribayashi@isas.jaxa.jp
Dr. Sven Reutzel
Institute of Space Simulation, German Aerospace Center (DLR), Cologne, Germany,
sven.reutzel@dlr.de
Prof. Dieter Herlach
Institute of Space Simulation, German Aerospace Center (DLR), Cologne, Germany,
dieter.herlach@dlr.de
Prof. Taketoshi Hibiya
University of Tokyo, Tokyo , Japan, hibiya@cc.tmit.ac.jp

TRANSFORMATION OF ND-FE-B METASTABLE PHASE SOLIDIFIED FROM UNDERCOOLED MELT

Abstract

To improve magnetic properties of the Nd-Fe-B magnets, it is crucial to eliminate soft magnetic inclusions such as soft magnetic α-Fe phase. Recently, several efforts have been devoted to producing the Nd-Fe-B alloys free from the α-Fe phase by undercooling solidification. In these works, it was expected that the direct crystallization of the Nd2Fe14B phase would suppress the formation of the α-Fe phase. Gao and co-workers, however, suggested that the metastable Nd2Fe17Bx phase is formed as the primary phase [1]. In addition, they showed that, even in the Nd14Fe79B7 alloy, in which the a-Fe phase is unstable, the Nd2Fe17Bx phase decomposes into the Nd2Fe14B and α-Fe phases at the post-recalescence cooling stage. Our previous works showed that the post-processing heat-treatment transforms the metastable phase into the Nd2Fe14B phase without forming the α-Fe phase [2]. These results imply that the kinetics of the transformation in the metastable phase at the post-recalescence cooling stage is different from that at the post-solidification heat-treatment. In the present study, the undercooling solidification of NdxFe(100-1.5x)B0.5x alloys was carried out in a drop tube. The objective of this investigation is to clarify the mechanism of the phase transformation in the rapidly solidified Nd-Fe-B alloys from the undercooled melt. Segments of ingot were induction melted in a helium atmosphere, and the molten alloy was then ejected into the 26m drop tube to obtain the metastable phase. The changes of the microstructure and the phase constituent during the heat-treatment of the as-dropped sample were carefully investigated as a function of sample diameters. A large amount of the Nd2Fe17Bx metastable phase was contained in the as-dropped samples. The heat-treatment of the as-dropped

samples induces a dual-stage phase transformation. The 1st stage of the phase transformation is the diffusive phase transformation from Nd2Fe17Bx and Nd-rich phases into the Nd2Fe14B phase at 950K, and the 2nd stage of the transformation is the decomposition of the metastable phase into the Nd2Fe14B and α-Fe phases at 1100K. Although both stages of the phase transformation is controlled by the diffusion of Nd atoms, transformation temperature for the 1st stage is decreased due to the large existence of the Nd-rich phase adjacent to the metastable phase.

[1] J. Gao, T. Volkmann and D. M. Herlach, Acta Mater. 50, 3003 (2002) [2] S. Ozawa, M. Li, S. Sugiyama, I. Jimbo, S. Hirosawa and K. Kuribayashi, Mater. Sci. Eng. A. 382, 295 (2004)