Magnetic and structural properties of hot deformed Nd-Fe-B magnets diffusion processed with NdHx compound in two-step die upset

Shu Liu[1,2*], Nam-Hyun Kang[2], Ji-Hun Yu[1], Hae-Woong Kwon[3], Jung-Goo Lee[1†]

[1]Powder & Ceramics Division, Korea Institute of Materials Science, 797 Changwondaero, Changwon 642-831, Korea

[2]Department of Materials Science and Engineering, Pusan National University, Busandaehak-ro 63 beon-gil, Geumjeong-gu, Busan 609-735, Korea

[3]Department Materials Science and Engineering, Pukyong National University, Nam-gu, Busan 608-739, Korea

[†]Corresponding author. Tel./fax: +82 55 280 3606/3392, E-mail address: jglee36@kims.re.kr

Nd-Fe-B magnets are known to exhibit a high maximum energy product and thus have attracted much attention for motors in hybrid and electric vehicles. The anisotropic dense Nd-Fe-B magnets could be prepared byhot pressing and die upsetting of rapidly solidified ribbons. During hot deformation, the plate-like grains of main phase tended to rotate by grain boundary sliding so that the easy direction of magnetization is parallel to the c-axes. This led to the highly anisotropic magnets. Moreover, the grain boundary sliding lead to stress concentration was accommodated by the interface-controlled solution-precipitation reaction by the Nd-rich phase along the grain boundaries. Therefore the grain refinement and grain rotation of a and c axes are important factors to influence the magnetic properties.

Dy or Dy compounds are known as the effective addition in increasing coercivity, howerver, Dy is a scarce resource and tends to be relatively expensive. Recently extensive efforts have been devoted to develop Dy-free high magnetic properties Nd-Fe-B magnets. Nd and its compound is also good candidate to increase coercivity. Specially The spark plasma sintering (SPS) technique supply the pressure from initial stage to the end has been widely concerned as a new pressure sintering process to consolidate Nd-Fe-B powders to full density at relatively lower temperatures in a short period of time which generates plasma uniform heat the materials and inhibits the grain growth.

In this work, two-step die upsetting process was carried out to realize grain refinement and sharp texture formation of the main phase, HDedNd-Fe-B magnets were produced by SPS through the optimized method and the NdHx compound was selected as the addition to increase the coercivity from diffusion process. The microstructure evolution of two steps die upsetting process and magnetic properties after dipping with addition were discussed in our work.

Keywords: NdFeB magnets, Hot deformation, Nd-Cu-Zn, microstructure, SPS

This research was supported by a grant from the Fundamental R&D Program for Core Technology of Materials funded by the Ministry of Knowledge Economy, Republic of Korea.