Effect of metallic glass infiltration on the coercivity and microstructure of Nd-Fe-B hot-deformed magnets

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Anisotropic hot-deformed Nd-Fe-B magnets have variety of high temperature applications such as servomotors and electric power steering motors. In order to raise their coercivity, grain boundary infiltration process using low melting eutectics, for example Nd-Cu and Nd-Dy-Cu was employed [1]. The binary eutectic of Nd-Cu is at 520 °C. In order to keep the infiltration temperature lower, and to possibly form an amorphous phase in the intergranular regions, further low melting alloy is preferred. In an attempt to realize the above, in the present work, a Nd-based bulk metallic glass (Nd-BMG) alloy with a nominal composition of $Nd_{60}Al_{10}Ni_{10}Cu_{20}$ (at.%) [2] was used for infiltration. The glassy alloy has a melting point at 481 °C, one of the lowest of all the Nd-based alloys. The study was extended to Pr-BMG ($Pr_{60}Al_{10}Ni_{10}Cu_{20}$) as well. The infiltration process was carried out at different temperatures between 600 and 700 °C. The resultant coercivity increased from 1.1 T up to 2.8 T (Fig.1), which is the highest value of coercivity achieved so far for the bulk magnets that do not contain the expensive heavy rare-earth elements Dy or Tb. High temperature coercivity also showed improvement (Fig.2). Formation of an amorphous phase in many intergranular regions was the most interesting feature of the microstructure (Fig.3). With detailed microscopic observations, crystallinity and chemistry of the intergranular phases were studied. After crystallization studies, it was found that coercivity does not majorly depend upon the crystallinity of the intergranular phase.

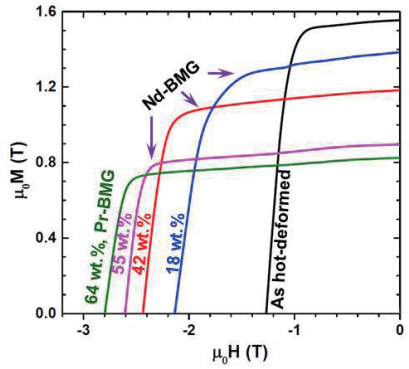

Fig.1: Magnetization curves before and after infiltration process

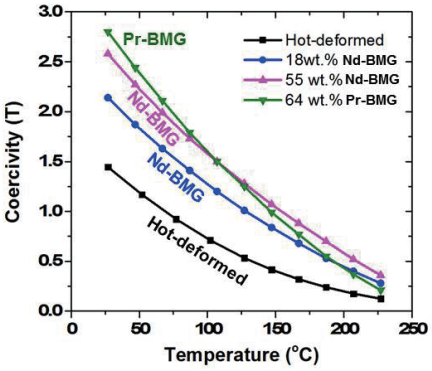

Fig.2: Temperature dependence before and after infiltration process

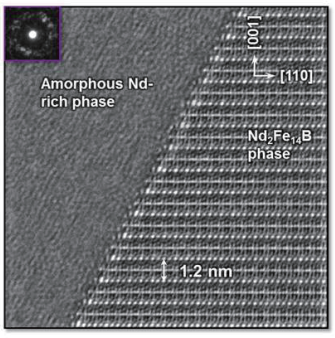

Fig.3: Amorphous grain boundary phase formation beside $Nd_2Fe_{14}B$ phase

References:
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2) Q. Luo, W.H. Wang, Journal of Non-Crystalline Solids 355 (2009) 759–775