Microstructure and magnetic properties of hot deformed NdFeB magnet by spark plasma sintering

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For hot deformed NdFeB magnets, good magnetic properties together with exceptional corrosion, thermal stability, and fracture toughness can be obtained. It is well known that the grains of NdFeB magnetshot deformed by die-upseting or extruding are elongated normal to the press direction with platelet-shaped and oriented in such a way that the c-axis of the NdFeB grains is normal to the platelet. Until now comprehensive investigations for further development of these kinds of magnets have been conducted on their processing conditions, microstructure as well as magnetic properties. Their preparation technique however is still a major concern since their magnetic properties deteriorate dramatically due to excessive grain growth during the densification and deformation processes by conventional methods.

The Spark Plasma Sintering (SPS) technique 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. One of the important advantages of SPS is the high sintering speed, which can effectively restrain the grain growth over the critical nanosize and allows the preparation of high-density fine crystalline materials. Hot deformed Nd-Fe-B compact with nanocrystallite texture has been successfully fabricated by SPS and a combination of SPS and hot deformation processes, respectively. However many points of the microstructure evolution have not yet been explained clear and the microstructural evolution mechanism during hot pressing and die upset need further studies. In the present work, commercially available Dy-free MQU-F melt spun ribbons with optimized composition $Nd_{13.6}Fe_{73.6}Co_{6.6}Ga_{0.6}B_{5.6}$ have been first hot compacted at 650°C in vacuum for 3 min and then followed by die upset by SPS. The effect of two stage processes on the magnetic properties was discussed, focusing on the microstructure after the deformation.

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