Solid-State Texture Development in Sintered Alnico-Based Permanent Magnets from High-Pressure Gas Atomized Powders for Traction Drive Technology

Aaron G. Kassen, Liangfa Hu, Emma M. White, Wei Tang, Andriy Palasyuk, Lin Zhou, Matthew J. Kramer, and Iver E. Anderson

Ames Laboratory (USDOE), Iowa State University, Ames, IA 50011

Abstract

The desire to create an electrified vehicle fleet in the United States and worldwide has stressed an already critical global rare earth supply. Automotive manufacturers have almost universally decided upon permanent magnet AC (PMAC) synchronous traction motors as the preferred drive technology due to their inherent efficiency. This makes the development of resource friendly, cost-effective net-shaped permanent magnets critical. The challenge is manufacturing a magnet with sufficient energy product and intrinsic coercivity, along with a preferred loop shape that can perform well in the challenging environment experienced by drive motors. This study explores using gas atomized alnico 8-based alloys for the development of solid-state processing of net-shape anisotropic permanent magnets with magnetic properties (measured with a hysteresisgraph) that are suitable for traction drive motors. Preferred texture during grain growth is promoted by applied uniaxial stress and analyzed by EBSD in a SEM.

Introduction

The onset of rapid rare earth (RE) price inflation in 2011, followed by subsequent extreme price depression has created a market crisis in the electric traction drive motor industry which has driven renewed research in permanent magnet technologies which are free from these politically and economically volatile materials.[1] Specifically, modern permanent motor manufacturers had extensively utilized neodymium-iron-boron (Nd-Fe-B) and samarium-cobalt (Sm-Co) high energy permanent magnets (HEPM) with energy products as high as 437 KJ/m^3(55 MGOe), particularly those containing dysprosium for enhanced high-temperature performance. Adapting RE containing HEPM to motor technology such as would be required in traction motor applications, meant leveraging even more costly and rare materials such as dysprosium and praseodymium to achieve effective magnet performance at temperatures in excess of 150°C, or more specifically allows operation at temperatures nearing 180°C (Figure 1), the target for OEM traction drive motor manufacturers, but results in dramatic reduction in energy product to only 160 KJ/m^3 (20 MGOe).[2]