Magnetic properties of Nd-Fe-B magnets made from gas-atomized powders

Belle Finney[1,2], Baozhi Cui[2], Matthew J. Kramer[1,2], Wei Tang[2], Jun Cui[1,2], and Iver E. Anderson[1,2]

[1]Materials Science and Engineering, Iowa State University,
Ames, Iowa 50011
[2]Ames National Laboratory,
Ames, Iowa 50011

ABSTRACT

Strong permanent magnets are important when developing electric vehicles; the impressive ambient temperature strength of Nd-Fe-B permanent magnets has been well-known since their 1980s discovery/development. Nd-Fe-B magnets have a wide variety of applications but are not used in high-temperature (>150C) applications, e.g., drive motors, without significant heavy rare earth (Dy or Tb) additions to maintain sufficient coercivity. To avoid the use of HRE additions, Nd-Fe-B magnets with ultrafine (<2-3 μm) grain size has been shown to improve ambient and high-temperature magnetic properties (1). However, the superfine (1-2 μm) powder feedstock has an enormous surface area that readily oxidizes which decreases magnetic saturation. Support from U.S. Department of Energy-EERE-Vehicle Technologies Office through Ames National Laboratory contract DE-AC02-07CH11358.

INTRODUCTION

Numerous scientific advancements and technological innovations have come in response to a need to improve or replace current processing or materials used in daily life. These changes often come about by various factors, including the environmental and health hazards associated with current methodologies. Potential contamination of the environment could cause a range of adverse effects on the people in proximity to the operations. Another major motivation is the increasing adoption of sustainable energy solutions. The electrification of cars means an increased need for electric motors and associated components. Current issues with supply chain restraints make some of the development of these parts problematic (2). Nd-Fe-B magnets are one such part that is incredibly important and difficult to source due to geopolitical supply risks.

Rare earth permanent magnets, particularly those based on Nd-Fe-B, have exceptional magnetic strength. This strength makes them invaluable in technological applications such as computers systems, hard drives, and electric motors. The absence of magnetic materials would have significantly impeded