Experimental Report

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Proposal: **CRG-174** **Council:** 4/1997

Title: Texture investigation of hardmagnetic materials produced byforging

This proposal is a new proposal

Researh Area:

Main proposer: **DE RANGO Patricia**

Experimental Team: RIVOIRARD Sophie
CHATEIGNER Daniel

Local Contact: SOUBEYROUX Jean-Louis

Samples:

Instrument	Req. Days	All. Days	From	To
D1B	5	5	12/08/1997	17/08/1997

Abstract:

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Texture investigation of hot-forged Nd–Fe–B magnets

S. RIVOIRARD†§, D. CHATEIGNER‡, P. DE RANGO†, D. FRUCHART†, R. PERRIER DE LA BATHIE† and J. L. SOUBEYROUX†

†Laboratoire de Cristallographie, CNRS, BP 166, 38042 Grenoble, France
‡Laboratoire de Physique de l'Etat Condense, Université du Maine, BP 535, 72085 Le Mans, France

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ABSTRACT

This work represents one of the first attempts to probe the bulk crystallographic alignment of hot-forged Nd–Fe–B–Cu magnets using neutron diffraction techniques. Optimizing the microstructure induced by the hot-forging process is necessary to develop good magnetic properties. For that purpose, understanding the deformation mechanisms in terms of thermal and mechanical behaviour is of great importance. Ingots of Nd–Fe–B–Cu alloy were cast into steel tubes and hot forged at 980°C. The magnetic properties and induced texture of the magnet were investigated. The results show a fair correlation between microstructural parameters induced by the deformation mode and magnetic properties. Using neutron diffraction analysis, the pole figures revealed the existence of a texture that was more pronounced in the centre than in the periphery of the forged specimen. The good magnetic properties are the result of grain size reduction during forging combined with $Nd_2Fe_{14}B$ crystallite alignment (*c* axis aligned along the forging direction). As the Nd–Fe–B alloy is in a semisolid state at the processing temperature, the fraction of intergranular liquid phase has to be sufficient to allow alignment of the solid $Nd_2Fe_{14}B$ particles but not too important to allow internal stresses between solid grains (resulting in cracks and size reduction). The compromise optimizing the magnetic properties is studied in this work.

§ 1. INTRODUCTION

Nd–Fe–B-type magnets have been produced since 1984 based on the hard magnetic phase $Nd_2Fe_{14}B$ (Sagawa *et al.* 1984). In this type of material, $Nd_2Fe_{14}B$ grains are separated from each other by a non-magnetic Nd-rich intergranular phase. This microstructure, when optimized, is the key for inducing coercivity in the magnet. The size of the magnetic grains as well as the composition and repartition of the minor intergranular phase must be controlled to avoid the propagation of domain walls. Furthermore, texturing the intrinsically anisotropic magnetic grains leads to enhancement of the inductive force of the magnet, which can be doubled. Improvements in the processes used to develop optimized textures are needed for the engineering of high energy product $(BH)_{max}$ magnets. Processing by hot deformation of cast ingots is a potentially simple and economic route that currently attracts our attention (Nozières *et al.* 1994). Recently, much work has been done on developing slow strain-rate processes (such as upset forging of cast Pr–Fe-B–Cu

§ Email: rivoirar@labs.polycnrs-gre.fr.

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