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Magnetic properties of composite cores made of nanocrystalline material for high frequency inductors and transformers

***Abstract**. By choosing parameters of production process of magnetic powder core (MPC) it is possible to develop magnetic properties of cores and match them to specific application. In this paper we show how production of MPC impacts on magnetics characteristics of magnetic cores.*

Keywords: Soft Magnetic Material, Magnetic Powder Core, Inductors, Transformers.

Introduction

A magnetic powder core (MPC) is a magnetic circuit, containing magnetic granular material, such as ferrite, iron, amorphous material or nanocrystalline material [1]. Characteristic attribute of MPC is a distributed-air-gap, achieved by filling free spaces between magnetic particles with binding material. This feature provides good saturation induction Bs and low specific power losses P. It does however decrease value of relative permeability μr [2] but is stable in broad range of frequency. MPC is generally applied in switching power supplies, filter inductors, smoothing chokes and coupling devices [1, 2]. This paper presents correlation between magnetic characteristic of MPC and parameters of production process of MPC.

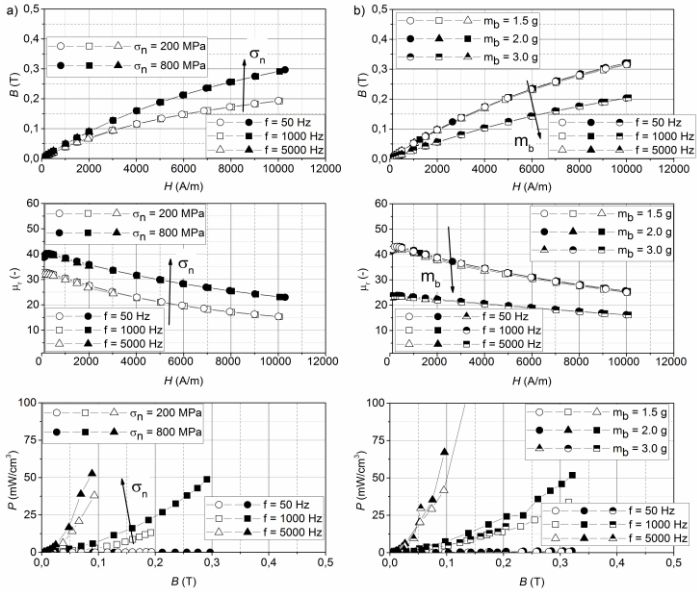

Fig.1. a, b, c - Influence of compact pressure σ_n to magnetic properties; d, e, f – influence of amount of binder m_b to magnetic properties, magnetic powder mass m_p = 21 g.

Production process of MPC

Parameters of each step of magnetic core preparation have significant influence on magnetic parameters of the core [6]. Step no. 1 consists of crushing and milling nanocrystalline strip and is strictly related to step no. 2, particle size distribution. It should be noted that granular analysis and powder classification are the most important parameters to obtain proper magnetic characteristic to be used in certain high frequency application [3]. Stages no. 3 and 4 are binding magnetic material and its compaction, respectively [1]. Final step, no 5, is thermal treatment of compressed mixture.

Magnetic properties of MPC

Below we demonstrate selected results, which show influence of step no 3 and 4 on final properties of MPC. In fig. 1. we demonstrate impact of magnetic powder density in core on its magnetic properties. More magnetic material in core's volume causes better magnetic properties of MPC. With higher value of pressure or lower amount m_b of binder, flux density B and relative permeability μr is raising, because we are increasing density of magnetic material in core. Specific power loss P is raising with value of compaction pressure however it is nearly the same with rising of amount of binder.

Conclusion

Selected results of arranged magnetic properties of MPC by modified production process condition were presented. The properties of composite core could be developed by strictly prepared production steps. By modifying the size of particles, mixture of different size classes, density of magnetic powder in core and thermal treatment condition, we have tools to adapt the core's magnetic properties to specific application.

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