January 10, 2017
Hitachi Metals, Ltd.

Hitachi Metals Announces the Development of Block Cores of High-frequency Power Converters for Handling over 100 kW Using FINEMET® Nanocrystalline Soft Magnetic Materials and Metglas® Amorphous Metals

Hitachi Metals, Ltd. is pleased to announce the successful development of block cores with both a high saturation magnetic flux density and low core loss at high frequencies using FINEMET® nanocrystalline soft magnetic materials and Metglas® amorphous metals. This product will minimize the size of transformers and reactors more than ever before.

1. Background

Power conditioners for renewable energy and auxiliary power supplies for railway vehicles employ coil products such as transformers and reactors for power conversion. Higher switching frequencies of semiconductors allow power converters to use smaller coil products, which can minimize the size of power converters.

However, the switching frequency and power capacity of conventional systems that use Si (silicon) semiconductors are limited by the withstand voltage and heat generation of semiconductors. Recently, the growing performance of IGBT[*1] using Si and the advent of next-generation semiconductors such as SiC (silicon carbide) and GaN (gallium nitride) have necessitated the use of a larger capacity and higher switching frequency more than ever before. High-frequency transformers and reactors using electrical steel sheets have a higher core loss[*2] in the high-frequency ranges, and suppression of the temperature rise caused by this loss makes it difficult to downsize the system.

2. Outline

Making full use of the technical characteristics of FINEMET® nanocrystalline soft magnetic materials and Metglas® amorphous metals, Hitachi Metals has developed F3BC FINEMET® block cores and AMBC amorphous block cores to fulfill the need for large cores of large-capacity transformers.

F3BC: can be used for square-ring shaped large cores, contributing to smaller transformers capable of handling over 100 kW of power

AMBC: can be easily employed for large multi-gap cores, contributing to reducing core loss caused by fringing flux[*3] and suppressing heat generation

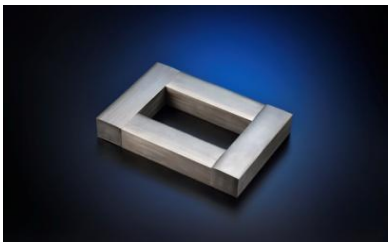

Photo: F3BC—FINEMET® block core

FINEMET® is suitable for transformer cores working at a high switching frequency—5 to 20 kHz in particular—whereas amorphous metals are suitable for reactor cores working with a high-frequency ripple[*4]. Since FINEMET® and amorphous metals have a significantly smaller core loss and higher switching frequency than electrical steel sheets, Hitachi Metals has provided UU-shaped cut cores made of FINEMET® and amorphous metals. The new block cores will contribute to the development of smaller and lighter transformers operating in a high-frequency range with higher efficiency in power transformation. In addition, we will not only provide block cores with a standard shape for initial evaluation, but also manufacture cores with shapes based on customer requests.

We will continue our quest to design materials that draw out the properties of raw resources, contributing to electronic components with a higher performance, and will address an even more extensive range of customer needs.

3. Production Status

Sample shipment: January, 2017
Mass production: Second half of FY2017

4. Production Bases

Hitachi Ferrite Electronics, Ltd.
Hitachi Metals (India) Pvt. Ltd.
Hitachi Metals (Thailand) Ltd.

5. Patents

Basic patents have been obtained.

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Supplementary Explanations

General characteristics (typical)

	F3BC (18μm)	AMBC (25μm)	Grain-oriented electrical steel sheet (0.23 mm)
Saturation magnetic flux density (Bs)	1.23 T	1.56 T	1.90 T
Magnetostriction (λs)	< 1 ppm	27 ppm	-0.8 ppm
Core loss (Pcm) 10 kHz, 0.1 T	0.4 W/kg	2.3 W/kg	25 W/kg
Curie temperature (Tc)	570 °C	392 °C	750 °C
Effective relative permeability (10 kHz)	5,000	3,000	---
Maximum operating temperature	130 °C	130 °C	---

* The values in the table are typical values. We do not guarantee the characteristics.

■ Applications: Inverters for railway vehicles, power conditioners for solar or wind power generation systems, and quick chargers

F3BC main features

(1) Low core loss and ideal for applications in a 5-20 kHz switching frequency
(2) High operating flux density is available.
(3) Low magnetostriction and low noise emission

AMBC main features

(1) Low core loss and ideal for high-frequency AC reactors
(2) Large multi-gap cores are available.

Glossary

*1 IGBT stands for insulated gate bipolar transistor, which is a power semiconductor switching device, and is used as a main conversion device for large-capacity power converters.
*2 Core loss is the loss of energy when an alternating magnetic field is applied to an iron core.
*3 A fringing flux is a magnetic flux leaking from the gap between iron cores. It causes an eddy current and increases core loss.
*4 A ripple is a small variation in a direct current. The larger the frequency or amplitude of a ripple current, the larger the core loss of the reactor.