Developing Magnetic Domain Control Type Fe-base Amorphous Metal, MaDC-A™

Hitachi Metals, Ltd. ("Hitachi Metals") has successfully developed MaDC-A™, which uses Metglas®, the Fe-based amorphous alloy ("Amorphous Alloy"), using magnetic domain control technology. MaDC-A™ has a high flux density and approximately 25% lower core loss*1 than the conventional products, which contributes to the higher efficiency of distribution transformers*2.

1. Background

In recent years, there has been a growing demand to cut CO₂ emissions as a countermeasure against global warming, creating a pressing need for energy saving. The energy efficiency standards for distribution transformers are becoming stricter in many countries, and, to comply with those standards, the development of metal core materials with a lower core loss is necessary.

2. Outline

The Amorphous Alloy’s lack of a crystalline structure causes it to have low hysteresis loss*3. In addition, it’s thinness and high electrical resistivity*4 create a characteristically low eddy-current loss*5. Therefore, use of the Amorphous Alloy results in lower core loss than magnetic steel sheets*6.

For over 20 years it has been recognized that core loss can be reduced by controlling magnetic domain*7 structure. However, technologies that can be adapted for mass production have not been established. Solving this issue that has plagued the industry for many years, Hitachi Metals has successfully developed a magnetic domain structure control technology that adapts to mass production. By applying this unique technology to Metglas®, developed by the company, Hitachi Metals has developed MaDC-A™, a new product with significantly reduced core loss.

MaDC is an acronym for “Magnetic Domain Controlled,” and MaDC-A™ features approximately 25% lower core loss than conventional products, thus greatly contributing to size and weight reduction, and the higher efficiency of distribution transformers. It is highly expected to reduce environmental burdens, saving energy and contributing to the prevention of global warming. In addition to MaDC-A™, Hitachi Metals has also developed MaDC-F™, a soft ferrite material that has been on the market since 2019, into a series, each of which is a product that outperforms conventional products to meet the need for higher efficiency.

Hitachi Metals will continue to improve the performance of materials and contribute to the further improvement of the performance of electric and electronic equipment to meet the wide range of customer needs.

3. Production Status

The supply of samples started in March 2020

The mass production is planned to start in the first half of FY2020

4. Production Location

Metglas Yasugi Works (Shimane Prefecture, Japan)

5. Patent

Basic patent obtained

For inquiries from the press: Corporate Communications Dept., Hitachi Metals, Ltd.

e-mail: hmc.sa@hitachi-metals.com
<Supplementary Explanations>

◆ Basic Properties

<table>
<thead>
<tr>
<th>Core material</th>
<th>New product, MaDC-A™ (2605MaDC)</th>
<th>Metglas® (2605HB1M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal sheet thickness (μm)</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Core loss (W/kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 Hz</td>
<td>1.4 T</td>
<td>0.08 typ.*1</td>
</tr>
<tr>
<td>1.3 T</td>
<td>0.06 typ.</td>
<td>0.08 typ.</td>
</tr>
<tr>
<td>1.4 T</td>
<td>0.09 typ.</td>
<td>0.13 typ.</td>
</tr>
<tr>
<td>1.3 T</td>
<td>0.07 typ.</td>
<td>0.10 typ.</td>
</tr>
<tr>
<td>60 Hz</td>
<td>1.3 T</td>
<td>0.09 typ.</td>
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<tr>
<td>Magnetic flux density (T)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>800 A/m*2</td>
<td>1.63 typ.</td>
<td>1.63 typ.</td>
</tr>
<tr>
<td>80 A/m</td>
<td>1.55 min.*3</td>
<td>1.50 min.</td>
</tr>
</tbody>
</table>

*1 The values in the table are typical values of amorphous single panel and do not guarantee the characteristics.

*2 Ampere/meter

*3 Minimum value

◆ Applications Distribution transformers, motors, etc.

◆ Features

1. Approx. 25% lower core loss than the conventional material Metglas® (2605HB1M)
2. A high magnetic flux density that is over 1.55T (when a magnetic field of 80A/m is applied)

<Definitions>

*1 Sum of the hysteresis loss and eddy-current loss
*2 Electric equipment that lowers the voltage from a substation to the voltage used in general houses, etc. before distribution
*3 Energy loss that does not depend on the frequency generated when a magnetic field is applied to the core
*4 Value that indicates the difficulty of conductivity
*5 Energy loss that occurs due to the eddy current generated when a DC magnetic field is applied to the core
*6 Magnetic material that consists of iron and silicon
*7 An area where a collection of minute magnets that exist in a ferromagnet is aligned in one direction