Source:JASE-W Japanese Smart Energy Products & Technologies
https://www.jase-w.eccj.or.jp/technologies/index.html

| E-06 | Keywords | Y1 | material or part | Z4 | electricity | E29 | electrical machinery |
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Hitachi, Ltd./Hitachi Metals, Ltd.

# Amorphous Alloy for Energy Efficient Distribution Transformer

## Features

- Principal uses, application range and versatility: Energy efficient transformer (oiled, dry and mold) for electric power distribution.
- Energy efficiency and energy conservation: The amorphous transformer contributes to the reduction in power loss in the power distribution grid since it has small no-load loss (equivalent to the standby power) at approx. 1/3 of the no-load loss of a cold-rolled grain-oriented electrical steel transformer. It also contributes to the reduction in $CO_2$ emission in the power generation, because it uses electric power efficiently.
- Innovative with price advantage: Initial costs of amorphous transformer is higher than the conventional transformers that use cold-rolled grain-oriented electrical steel, but since the loss of electric power is lower, the running costs are less and therefore in terms of life cycle costs the amorphous transformer is cheaper [*2].
- Weather resistance and durability, etc: Equivalent to cold-rolled grain-oriented electrical steel transformers.
- Ease of material procurement: Materials being mass produced by Metglas® Yasugi Works of Hitachi Metals, Ltd., as well as at Metglas® [*3] in the United States (our wholly owned subsidiary).

*1: According to the Research and Development News of Chubu Electric, No. 129/2008-1 (http://www.chuden.co.jp/resource/corporate/news_129_N12913.pdf)
*2: Lot 2: Refer to Figure 6-2 of the Distribution and power transformers Draft Tasks 1 – 7 Report http://www.ebpg.bam.de/de/ebpg_medien/entr2/402_studyf_11-01_part1-7.pdf#search='LOT%202: %20Distribution%20and%20power%20transformers%20Draft%20Tasks%201%20–%207,%20Jan%202011'
*3: Metglas® is a registered trademark of Metglas®, Inc.

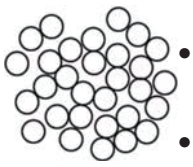
## Basic Concept or Summary

### ■ Features of amorphous (non-crystalline) alloys

**Cold-rolled grain-oriented electrical steel (crystal)**

- Regular atomic arrangement →Crystalline magnetic anisotropy
- Electric resistivity (0.50μΩ・m) →Equivalent to or less than half of the amorphous alloy
- Thickness (0.23 to 0.35mm) →About ten times thickness of amorphous alloy

**Amorphous (non-crystalline) alloy**

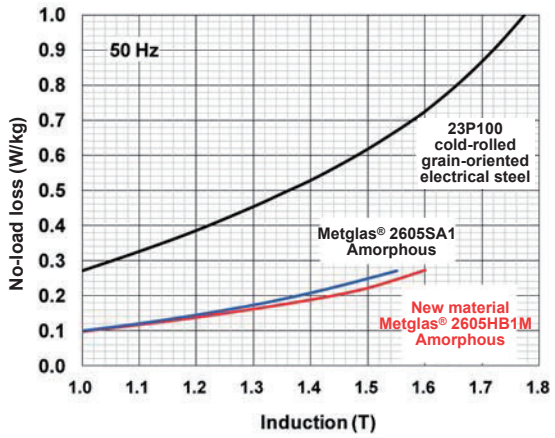


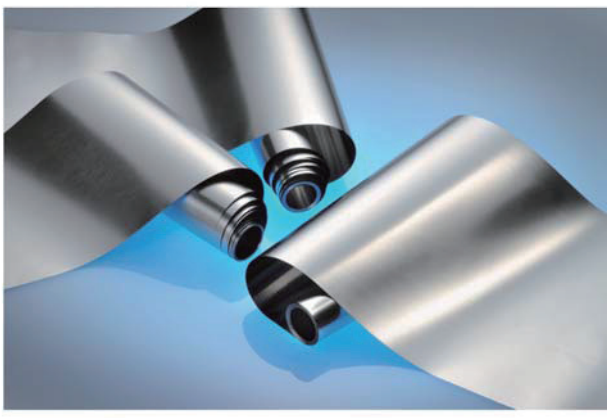
- Irregular atomic arrangement →Non-crystalline magnetic anisotropy exists
- Electric resistivity (1.20μΩ・m) →More than double the thickness of cold-rolled grain-oriented electrical steel
- Thickness (0.025mm) →About one tenth thickness of cold-rolled grain-oriented electrical steel

No-load loss is about one-third of cold-rolled grain-oriented electrical steel.

### ■ Comparison of magnetic characteristics for amorphous core and cold-rolled grain-oriented electrical steel core (50Hz)

**No-load loss of amorphous core is about one-third that of cold-rolled grain-oriented electrical steel core.**



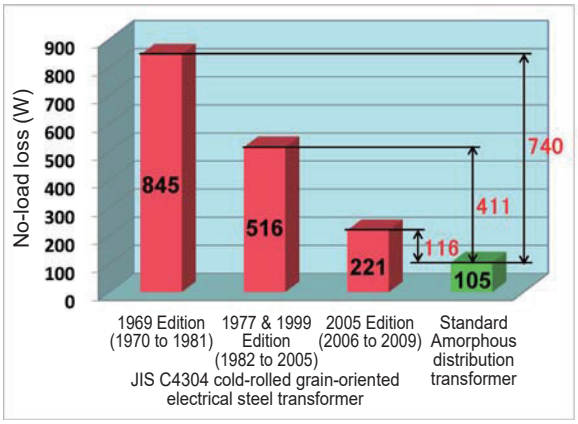



## Effects or Remarks

Our amorphous alloy Metglas® 2605SA1 and 2605HB1M can significantly reduce the losses that occur with transformers during electric power transformations, in comparison with cold-rolled grain-oriented electrical steel, due to superior soft magnetic characteristics (amorphous structure and thin), which contribute greatly to energy conservation and reducing carbon dioxide emissions.

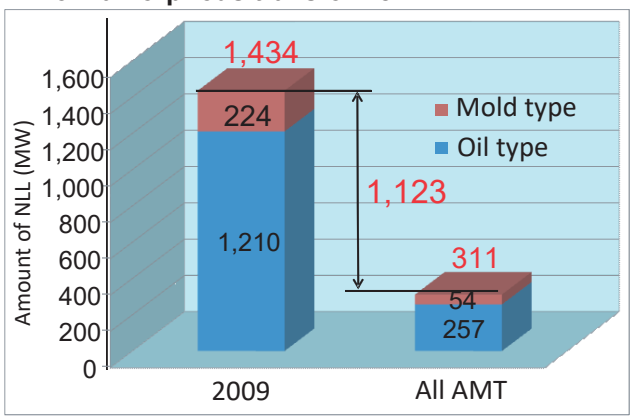
- ◆ No-load loss of transformers is about one-third that of cold-rolled grain-oriented electrical steel transformers.
- ◆ Superior melting and casting technologies achieve a mass production of highly reliable wide and thin amorphous ribbon.
  Furthermore, the new material Metglas® 2605HB1M makes it possible to reduce the size of amorphous transformers which is made from 2605SA1(conventional amorphous alloy).

### ■ Comparison of no-load loss among transformers




*The closest standard transformer capacity based on the average capacity of consumer oil-filled transformers, according to the results of a survey conducted by Hitachi Industrial System.

### ■ Estimation of energy conservation effects from amorphous transformer




**1. Effect when all industrial transformers in Japan are replaced to amorphous transformers**

1) Reduction of NLL : 1,123 MW → 9.84 TWh/yr
   ( Corresponds to 1.1% out of total demand (858.5TWh/yr) in 2009 )
2) Electricity cost reduced by around 108 Byen/yr*
3) Reduction of $CO_2$ emission : 4.08 M ton $CO_2$/yr**
   (Corresponds to 0.34% out of total $CO_2$ emission (1201M ton $CO_2$/yr) in 2009 )

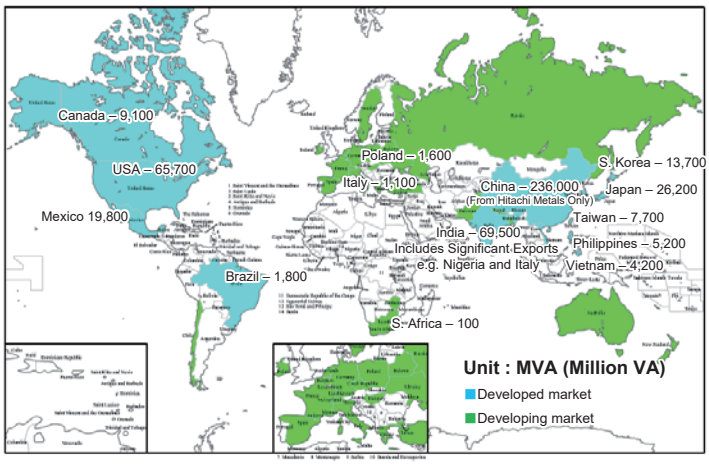
**2. Effect when all pole-type transformers in Japan are replaced to amorphous distribution transformers**

1) Reduction of NLL : 409 MW → 3.58 TWh/yr
   ( Corresponds to 0.42% out of total demand (858.5TWh/yr) in 2009 )
2) Reduction of $CO_2$ emission : 1.49 M ton $CO_2$/yr**
   (Corresponds to 0.12% out of total $CO_2$ emission (1201M ton $CO_2$/yr) in 2009 )

*Electricity price for calculation : ¥11/kWh
**Emission factor of Utility (2009) for calculation :0.415 kg - $CO_2$/kWh

## Installation in Practice or Schedule

**Domestic**
**Overseas**




Capacity of amorphous transformers installed in each country as ｓ of the end of 2017 (our estimate). Transformer capacity varies in each country.

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