Amorphous Alloys for Transformer Cores

**Metglas® Amorphous Transformer** cores are manufactured from low loss **Metglas® 2605SA1** and **Metglas® 2605HB1M** transformer core alloys. These low loss, high permeability alloys have excellent performance for single and three phase commercial, industrial and distribution transformer applications.

1. **Alloys and the specification**

<table>
<thead>
<tr>
<th>Alloy</th>
<th>2605SA1</th>
<th>2605HB1M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction at 60 Hz and 80 A/m* (T)</td>
<td>≥1.35</td>
<td>≥1.50</td>
</tr>
<tr>
<td>Core Loss* (W/kg)</td>
<td>at 60 Hz and 1.3 T</td>
<td>≤0.17</td>
</tr>
<tr>
<td></td>
<td>at 60 Hz and 1.4 T</td>
<td>≤0.20</td>
</tr>
<tr>
<td>Exciting Apparent Power* at 60 Hz and 1.4 T (VA/kg)</td>
<td>≤1.10</td>
<td>≤0.50</td>
</tr>
</tbody>
</table>

* These numbers in the above table are measured according to ASTM A 932/A 932 M - 01.

2. **General Properties and Characteristics**

**Electromagnetic**

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Saturation Induction (T)</th>
<th>Electrical Resistivity (μΩm)</th>
<th>Magnetostriction (x10^-6)</th>
<th>Curie Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2605SA1</td>
<td>1.56</td>
<td>1.3</td>
<td>27</td>
<td>395</td>
</tr>
<tr>
<td>2605HB1M</td>
<td>1.63</td>
<td>1.2</td>
<td>27</td>
<td>364</td>
</tr>
</tbody>
</table>

The numbers in the above table are not guaranteed.

**Physical**

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Density (g/cm³)</th>
<th>Crystallization Temperature (°C)</th>
<th>Tensile Strength (N/mm²)</th>
<th>Young's Modulus (GPa)</th>
<th>Vickers Hardness Hv-50 g load</th>
<th>Thermal Expansion Coefficient (x10^-6 °C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2605SA1</td>
<td>7.18</td>
<td>510</td>
<td>2,000</td>
<td>110</td>
<td>900</td>
<td>30 - 300°C</td>
</tr>
<tr>
<td>2605HB1M</td>
<td>7.33</td>
<td>489</td>
<td>2,100</td>
<td>120</td>
<td>900</td>
<td>4.3</td>
</tr>
</tbody>
</table>

The numbers in the above table are not guaranteed.

3. **Ribbon Dimensions and Lamination Factor**

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Thickness (µm)</th>
<th>Standard Available Widths (mm)</th>
<th>Lamination Factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2605SA1</td>
<td>25 ± 4</td>
<td>142.2 ± 1.0</td>
<td>≥84</td>
</tr>
<tr>
<td>2605HB1M</td>
<td>25 ± 4</td>
<td>170.2 ± 1.1</td>
<td>≥84</td>
</tr>
</tbody>
</table>

4. **Typical Magnetic Properties**

In the following pages some examples of the properties on 2605SA1 and 2605HB1M transformer core alloys are shown. AC magnetic properties were measured by 25 cm Epstein test frame method. DC hysteresis curves were measured by a Single Strip Test method. The samples were 25.4 mm wide and 200 mm long. The heat treatment of the samples were performed at 370°C for 2 hours for 2605SA1 alloy and at 340 °C for 2 hours for 2605HB1M alloy in a magnetic field of 2400 A/m directed along the long axis of the ribbon to release stress and induce the magnetic anisotropy along the long axis of the ribbon. These properties are not guaranteed.
These curves are typical
These curves are typical.
This curve is typical.
These curves are typical
This curve is typical.
These curves are typical
These curves are typical.
This curve is typical
These curves are typical: 2605HB1M DC Hysteresys Curves Sample: Straight Strip (25.4mm wide, 200mm long)
2605HB1M
Measured by Vibrating Sample Magnetometer

This curve is typical
5. Typical Magnetic Properties of Transformer Core

Some examples of the properties on 2605SA1 and 2605HB1M transformer cores are shown. They were annealed at 350°C for 1 hour for 2605SA1 core and at 320°C for 1 hour for 2605HB1M core. These properties are not guaranteed.
Core for Single-Phase Transformer
Annealing Condition:
  - Longitudinal Field Anneal (350 °C 1 hour)
  - Over Lap Joint
  - Ribbon Width: 170 mm (6.7")
  - Core Weight: 73 kg

These curves are typical.
These curves are typical.

Core for Single-Phase Transformer

Annealing Condition:
Longitudinal Field Anneal (350 °C without Soak)

Over Lap Joint
Ribbon Width: 170 mm (6.7”)
Core Weight: 73 kg

2605SA1 Transformer Core

f = 50 Hz

Operating Temperature
25 °C 75 °C 95 °C 135 °C
Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (350 °C without Soak)
Over Lap Joint
Ribbon Width: 170 mm (6.7”)
Core Weight: 73 kg

These curves are typical.

205SA1 Transformer Core
f = 60 Hz

Operating Temperature
25 °C
75 °C
95 °C
135 °C
Induction (T)

Exciting apparent power (VA/kg)

These curves are typical.

2605SA1 Transformer Core

f = 50 Hz

Core for Single-Phase Transformer

Annealing Condition: Longitudinal Field Anneal (350 °C without Soak)

Over Lap Joint

Ribbon Width: 170 mm (6.7”)

Core Weight: 73 kg

Operating Temperature

25 °C

75 °C

95 °C

135 °C

These curves are typical.
These curves are typical. 2605 SA1 Transformer Core

- **Core for Single-Phase Transformer**
- **Annealing Condition:** Longitudinal Field Anneal (350 °C without Soak)
- **Over-Lap Joint**
- **Ribbon Width:** 170 mm (6.7”)
- **Core Weight:** 73 kg

**Operating Temperature**
- 25 °C
- 75 °C
- 95 °C
- 135 °C

These curves are typical.
DC Hysteresis Curve of 2605SA1 Transformer Core

H_m = 80 A/m

Core for Single-Phase Transformer
Annealing Condition: Longitudinal Field Anneal (350 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 73 kg

This curve is typical.
Core Loss of 2605HB1M Transformer Core

Core for Single-Phase Transformer
Annealing Condition: Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 75 kg

These curves are typical.
Exciting Power of 2605HB1M Transformer Core

Core for Single-Phase Transformer
Annealing Condition:
  Longitudinal Field Anneal (320 °C 1 hour)
  Over Lap Joint
Ribbon Width: 170 mm (6.7”)
Core Weight: 75 kg

These curves are typical.
Induction (T) vs. Core loss (W/kg)

Core for Single-Phase Transformer
Annealing Condition: Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 75 Kg

These curves are typical.

2605HB1M Transformer Core
f = 50 Hz

Operating Temperature
25 °C
75 °C
95 °C
135 °C
2605HB1M Transformer Core
f = 60 Hz

Operating Temperature
25 °C
75 °C
95 °C
135 °C

Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7”)
Core Weight: 75 kg

These curves are typical.
Induction (T)

2605HB1M Transformer Core
Core for Single-Phase Transformer
Annealing Condition: Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7”)
Core Weight: 75 kg

These curves are typical.

Operating Temperature
25 °C
75 °C
95 °C
135 °C

20, 50 Hz

2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0

Exciting Apparent Power (VA/kg)

1.1
1.2
1.3
1.4
1.5
1.6

Induction (T)
2605HB1M Transformer Core

- Core for Single-Phase Transformer
- Annealing Condition: Longitudinal Field Anneal (320 °C 1 hour)
- Over Lap Joint: 170 mm (6.7")
- Ribbon Width: 170 mm (6.7")
- Core Weight: 75 kg

These curves are typical.

Operating Temperature:

- 25 °C
- 75 °C
- 95 °C
- 135 °C

Induction (T)

Exciting Apparent Power (VA/kg)
DC Hysteresis Curve of 2605HB1M Transformer Core
$H_m = 80 \text{ A/m}$

Core for Single-Phase Transformer
Annealing Condition:
Longitudinal Field Anneal (320 °C 1 hour)
Over Lap Joint
Ribbon Width: 170 mm (6.7")
Core Weight: 75 kg

This curve is typical.