Nittobo New Glass fabric for PCB

Nitto Boseki Co., Ltd.
Glass Fiber Division
Technical Dept.
Nov. 2011

The contents of this document are based on the results of experiments, investigations and analyses conducted by Nitto Boseki Ltd. (Nittobo). Nittobo does not intend to guarantee the value. Nittobo reserves the right to change these typical values as a natural process of refining our test equipment and techniques.
PCB Market and Nittobo’s Target

- IC Substrate
  - CSP
  - BGA
  - Low CTE
  - High Quality and Reliability

- High Speed
  - Switching system
  - Low Dk
  - Low Df

T-glass

NE-glass

ETCC ABS
Engine Controller PCB

SS process, NHR process

Confidential
1. **T-glass fabrics**

Contents

1-1. Why Low CTE?
1-2. Glass Fiber Composition
1-3. Properties of glass fiber
1-1. Why Low CTE?

PCB receives the heat stress by thermal expansion.

Connected reliability decrease

CTE:
- 3~4 ppm/℃
- 9~11 ppm/℃

Demanded for low T-glass fabric respond
### 1-2. Glass Fiber Composition

Nittobo is integrated Glass Fiber Manufacturer. (Yarn & Fabric)
Nittobo can develop a different component Glass Fiber.

<table>
<thead>
<tr>
<th></th>
<th>E-glass</th>
<th>T-glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO$_2$</td>
<td>52-56</td>
<td>64-66</td>
</tr>
<tr>
<td>Al$_2$O$_3$</td>
<td>12-16</td>
<td>24-26</td>
</tr>
<tr>
<td>B$_2$O$_3$</td>
<td>5-10</td>
<td>-</td>
</tr>
<tr>
<td>CaO</td>
<td>20-25</td>
<td>-</td>
</tr>
<tr>
<td>MgO</td>
<td>0-0.8</td>
<td>9-11</td>
</tr>
<tr>
<td>R$_2$O</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

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# 1-3. Properties of glass fiber

<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>E-glass</th>
<th>T-glass</th>
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</thead>
<tbody>
<tr>
<td>Density</td>
<td>g/cm³</td>
<td>2.6</td>
<td>2.5</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>GPa</td>
<td>3.2</td>
<td>4.8</td>
</tr>
<tr>
<td>Tensile Modulus</td>
<td>GPa</td>
<td>75</td>
<td>86</td>
</tr>
<tr>
<td>Dielectric Constant</td>
<td>(1GHz)</td>
<td>6.8</td>
<td>5.4</td>
</tr>
<tr>
<td>Dissipation factor</td>
<td>(1GHz)</td>
<td>0.0035</td>
<td>0.0043</td>
</tr>
<tr>
<td>Volume Resistance</td>
<td>Ω・cm</td>
<td>$10^{15}$</td>
<td>$10^{15}$</td>
</tr>
<tr>
<td>Specific Heat</td>
<td>J/kg・K</td>
<td>763</td>
<td>774</td>
</tr>
<tr>
<td>Thermal Expansion</td>
<td>ppm/℃</td>
<td>5.6</td>
<td>2.8</td>
</tr>
<tr>
<td>The Point softening</td>
<td>℃</td>
<td>844</td>
<td>&gt;1000</td>
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IC Substrate
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High Speed
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- High Quality and Reliability
- Low Dk
- Low Df

T-glass
- ETCC ABS
- Engine Controller PWB

H-glass

SS process

NHR process
2. NE-glass fabrics

Contents

2-1. Why Low Dk and Df ?
2-2. Glass Fiber Composition
2-3. Properties of glass fiber
2-1. Why Low $D_k$ and $D_f$?

The high speed signal has been used for an electronic device.

<table>
<thead>
<tr>
<th>Transmission speed ($V$)</th>
<th>Transmission loss ($a$)</th>
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<tr>
<td>$V = \frac{C}{\sqrt{D_k}}$</td>
<td>$a = f \times \sqrt{D_k} \times D_f$</td>
</tr>
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</table>

($C$ : Velocity of light)

($f$ : Frequency)

Demanded for lower $D_k$ and $D_f$ materials. NE-glass fabric responds.
2-2. Glass Fiber Composition

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High Quality and Reliability

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NE-glass

SS process, NHR process

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3. SS process

Contents

3-1. What’s SS process?
3-2. Characteristic impedance
3-3. Summary
3-1. What’s SS process

**Conventional process**

**Basket hole**

\[ SS = \text{Smart Surface} \]
The technical key of SS process:
- Spread out and Flatten fiber technique
- Uniform distribution of filaments
Advantage of the fabric with SS process:

- Surface smoothness
- Dimensional stability
- Laser drill-ability
- Characteristic impedance
3-2. Characteristic impedance ($Z_0$)

\[
Z_0 = \frac{60}{\sqrt{\varepsilon_r}} \ln \frac{5.98 \cdot b}{0.8 \cdot W + t}
\]

<Microstripline>
Z₀ measurement

Conventional process

SS process

Circuit length : 10cm
3-3. Summary

Conventional process

- Dk distribution is uneven
- Thickness of the board varies widely

SS process

- Dk distribution is even
- Thickness of the board varies small

Excellent characteristic impedance

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Confidential
4. NHR process

Contents

4-1. Resin impregnation measurement
4-2. Influence by the viscosity of the resin
4-3. Summary
4-1. Resin impregnation measurement

Fabric type : 1027
Resin : FR-4

Before measuring

Conventional process

NHR process

After 10 seconds

Conventional process

NHR process

Ending impregnation
Impregnation characteristics for several fabric types:

Resin: FR-4 (100cps)

Diagram:
- Conventional process
- NHR process

End point (min): The fabric became transparent

Reference.

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4-2. Influence by the viscosity of the resin

Fabric type : 1027

Resin : FR-4

Viscosity of resin (cps)

End point (min)

Conventional process

NHR process

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4-3. Summary

- Large improvement resin impregnation characteristics for several fabric type.

- Excellent impregnation characteristics in the resin of the high viscosity.

- **Suitable for special resin**
- **Suitable for high insulation reliability**
The product with parentheses shows unregistration in IPC spec.
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NE-glass Fabric Products

Development.
Conclusion

We will keep developing high-performance glass fabric!