DIRECT BOND COPPER SUBSTRATES
Specifications and Design Rules

Material Combinations

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Al₂O₃</th>
<th>AlN</th>
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STANDARD Al₂O₃

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STANDARD AlN

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Geometric Properties

Mastercard Overall Plate size:
Nominal 5.5” x 7.5”
Actual 5.43” x 7.50”

Maximum usable Cu area: 5.0” x 7.0”

Overall thickness tolerance of ceramic + copper:
+7%/-10%

Ceramic perimeter tolerance:
Al₂O₃ as fired ±2%
AlN as fired ±0.5%

Copper surface finish:
Rₐ ≤ .002”; Rₓ ≤ .00008”; Rₙ ≤ .00063”

Physical Properties

- Thermal conductivity: Al₂O₃ 24-26 W/mK @ 20°C
  AlN 170-180 W/mK @ 20°C
- Electrical resistivity: >10¹ Ωcm
- Dielectric constant: Al₂O₃ 9.8 ±10% @ 1MHz
  10.0 ±10% @ 1GHz
  AlN 9.0 ±10% @ 1MHz
- Dielectric loss: Al₂O₃ 0.0003 @ 23°C, 1MHz
  0.0005 @ 23°C, 1MHz
- Dielectric strength (DC): Al₂O₃ 20 kV/mm @ .025”
  28 kV/mm @ .010”
  AlN 20 kV/mm @ .025”
- Copper peeling strength: Al₂O₃ ≥22.8 lb/in. @ 2 in./min
  AlN ≥28.6 lb/in. @ 2 in./min
- Operating temperature: -55°C to +850°C
  (critical in H₂ atmosphere >400°C)
- E-Module (blank ceramic): Al₂O₃ 340 GPa
  AlN 320 GPa
- Electrical conductivity: (Cu surface) 58 x 10⁶ S/m
**Physical Properties Cont’d**

- **Bending Strength:**
  - (blank ceramic) Al₂O₃: > 350 N/mm²
  - AlN: > 300 N/mm²
  - Coefficient of linear thermal expansion for bare Cu (dependent on Cu thickness):
    - Al₂O₃: 6.8 ppm/K @ 20°C - 300°C
    - 7.3 ppm/K @ 20°C - 600°C
    - 8.0 ppm/K @ 20°C - 1000°C
    - 4.7 ppm/K @ 20°C - 300°C
    - AlN: 5.2 ppm/K @ 20°C - 600°C
    - 5.6 ppm/K @ 20°C - 1000°C

**Design Rules**

- **Minimum width of Copper lines**
- **Minimum width of spaces**
  - Tighter tolerances are possible but not guaranteed in volume production.

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<tr>
<th>Min. Width</th>
<th>Copper thickness</th>
<th>Minimum Pitch</th>
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<tbody>
<tr>
<td>Typical .012”</td>
<td>@&lt;=0.005”</td>
<td>.024”</td>
</tr>
<tr>
<td>Minimum .010”</td>
<td>@&lt;=0.005”</td>
<td>.020”</td>
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<tr>
<td>Typical .020”</td>
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<td>Typical .0275”</td>
<td>@&lt;=0.010”</td>
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- **Copper pull back:**
  - (lasered edge)
  - Typical P > .020” ± .012”
  - Minimum P = .014” ± .010”
  - Depends on copper thickness

- **Front to back alignment:**
  - A = ± .008”

- **Etching tolerance:**
  - Typical ±0.006” @ ≤0.008” Cu
  - Minimum ±0.004” @ ≤0.008” Cu
  - Typical ±0.008” @ ≤0.012” Cu
  - Minimum ±0.006” @ ≤0.012 Cu

- **Taper of etched pattern:**
  - Maximum ½ Cu thickness

- **Ceramic perimeter tolerance:**
  - Single parts laser scribed
  - E = +0.008”/-0.002” @ ≤0.025”
  - E = +0.012”/-0.002” @ >0.025”

- **Chips along ceramic edge:**
  - Length of chip: maximum 1 x ceramic thickness
  - Width of chip: ½ x ceramic thickness

- **Surface plating:**
  - (All over)
  - Electroless Nickel 80μ” - 400μ” (8%±2% Phosphorus)
  - Pd 2μ” - 12μ”
  - Immersion Au 0.4μ” - 2μ”
  - Electroless Au 2μ” - 50μ”

- **Bonding Area (wetting):** ≥90%

- **Wire bonding:**
  - Standard Copper surface suitable for Stitch bond <8 mil Al, Au, Cu wire, > 8 mil wire
  - Requires a ball bond.

  *No lift off allowed during pull test @ 10 mil Al wire*