**Information About FOx®-1x and FOx-2x Flowable Oxides**

**DESCRIPTION**

FOx Flowable Oxide is a flowable, inorganic polymer that is designed to meet industry demands for improved dielectric materials. FOx Flowable Oxide is a direct replacement for low-temperature CVD and SOG processes. These materials are semiconductor grade (<10 ppb trace metals). They are available in several versions to produce a range of thicknesses up to 1.2 µm with a single coat.

A choice of carrier solvent system is also available. First-generation FOx Flowable Oxide (now referred to as “FOx-1x Flowable Oxide”) uses methyl isobutyl ketone (MIBK) as its carrier solvent, whereas second-generation FOx Flowable Oxide (“FOx-2x Flowable Oxide”) uses a volatile methyl siloxane (VMS) fluid blend as the carrier solvent.

Both solvent systems volatilize rapidly from the resin, leaving a planar surface. Cured films from both systems are essentially identical when tested for film stress and dielectric constant, and using FTIR comparisons. (See Figure 1.)

**TYPICAL PROPERTIES**

These values are not intended for use in preparing specifications.

<table>
<thead>
<tr>
<th>Property</th>
<th>FOx-14</th>
<th>FOx-15</th>
<th>FOx-16</th>
<th>FOx-17</th>
<th>FOx-22</th>
<th>FOx-23</th>
<th>FOx-24</th>
<th>FOx-25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness Range, Å</td>
<td>2700-3500</td>
<td>3800-4900</td>
<td>5200-6700</td>
<td>7000-9000</td>
<td>2400-3300</td>
<td>3200-4400</td>
<td>4300-6000</td>
<td>5800-8100</td>
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<tr>
<td>Trace Metal Impurities, ppb</td>
<td>&lt;10</td>
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<tr>
<td>Film Density, g/cm³</td>
<td>1.4</td>
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<tr>
<td>Film Stress (Tensile), MPa</td>
<td>80-100</td>
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<tr>
<td>Dielectric Constant, 1 MHz</td>
<td>3.0</td>
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<tr>
<td>Film Non-Uniformity, percent RSD</td>
<td>&lt;1</td>
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</tbody>
</table>

1For typical spin speeds of 2000-4000 rpm.

2Typical FOx Flowable Oxide properties, processed at 400°C (752°F) in nitrogen ambient.

**TYPICAL APPLICATIONS**

The characteristics of FOx Flowable Oxide make it an ideal material for use as an interlevel dielectric in multilevel metal integrated circuit designs. The material also can be used to markedly improve topside planarity when applied prior to final passivation.

However, unlike MIBK, the VMS fluids are exempt from federal and state regulations covering volatile organic compounds (VOCs). In addition, the FOx-2x Flowable Oxide products are odor-free and compatible with a broader range of plastic materials than are the FOx-1x Flowable Oxide products.

Semiconductor-grade MIBK and siloxane rinse solvents are available from Dow Corning as companion products. The line rinse solvents conform to the same impurity and particle specifications as the FOx Flowable Oxide products.

FOx-1x Flowable Oxide products include FOx-14, FOx-15, FOx-16, and FOx-17. FOx-2x Flowable Oxide products include FOx-22, FOx-23, FOx-24, and FOx-25.

**SPECIFICATION WRITERS:** Please obtain copies of the Dow Corning Sales Specifications for these products and use them as a basis for your specifications. They may be obtained from any Dow Corning Sales Office, or from Dow Corning Customer Service in Midland, MI. Call (517) 496-6000.
The flowable oxide film features state-of-the-art surface planarization, a low dielectric constant, controlled film thickness, excellent gap fill, and very low defect density. Additional information in the form of process notes prepared by Dow Corning engineers is available by calling (517) 496-6807.

**LIMITATIONS**

Dow Corning neither represents nor tests this material for medical device applications or for pharmaceutical end-use.

**HOW TO USE**

FOx Flowable Oxide is applied using standard spin-on glass equipment. It can be spin-coated under a wide range of conditions, which will optimize uniformity on complex geometries. After spin-coating, hot plates are used not only to remove solvent as with conventional SOGs, but also to melt and flow the film. The melt and flow properties of the material help to provide superior smoothing and gap fill.

After flow, the film is cured in a standard quartz diffusion furnace. At this point, the material is ready for the next processing step. No etchback is required.

**SHIPPING LIMITATIONS**

See Material Safety Data Sheet.

**STORAGE AND SHELF LIFE**

Refer to the Sales Specifications for these products.

**PACKAGING**

FOx Flowable Oxide is available in 125-, 250-, and 500-mL and 1-L (4- and 8-fl oz, 1-pt, and 1-qt) containers.

**PATENT POSITION**

Twenty percent (20%) of the purchase price of this material is applied to a license for the manufacture of semiconductors using one or more of the following U.S. patents, their foreign equivalents, or improvement within the scope of their claims: U.S. patent numbers 4,756,977; 5,059,448;
FIGURE 1: Final Cured Film Characteristics, Measured by FTIR

Processed at 400°C (752°F) for 1 hour in a quartz tube furnace in nitrogen ambient.

5,145,723; 5,118,530; 5,436,029; 5,336,532; 5,370,903; 5,370,904; 5,372,842; 5,380,567; and 5,441,765.

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