

Information About *FOX*[®]-1x and *FOX*-2x Flowable Oxides

Type

Inorganic polymer

Physical Form

- **As Supplied**

Liquid solution of hydrogen silsesquioxane in carrier solvent

- **As Processed**

Spun-on flowable polymer cured to a microporous amorphous film

Special Properties

State-of-the-art planarization; low dielectric constant; controlled film thickness; excellent gap fill; very low defect density; choice of carrier solvent systems

Primary Uses

Interlevel dielectric material in multilevel metal integrated circuit designs

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.)

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.

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.

TYPICAL PROPERTIES

These values are not intended for use in preparing specifications.

Thickness Range, Å ¹	
<i>FOX</i> -14	2700-3500
<i>FOX</i> -15	3800-4900
<i>FOX</i> -16	5200-6700
<i>FOX</i> -17	7000-9000
<i>FOX</i> -22	2400-3300
<i>FOX</i> -23	3200-4400
<i>FOX</i> -24	4300-6000
<i>FOX</i> -25	5800-8100
Trace Metal Impurities, ppb.....	<10
Film Density ² , g/cm ³	1.4
Film Stress (Tensile), MPa.....	80-100
Dielectric Constant, 1 MHz	3.0
Film Non-Uniformity, percent RSD	<1

¹For typical spin speeds of 2000-4000 rpm.

²Typical *FOX* Flowable Oxide converted film properties, processed at 400°C (752°F) in nitrogen ambient.

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

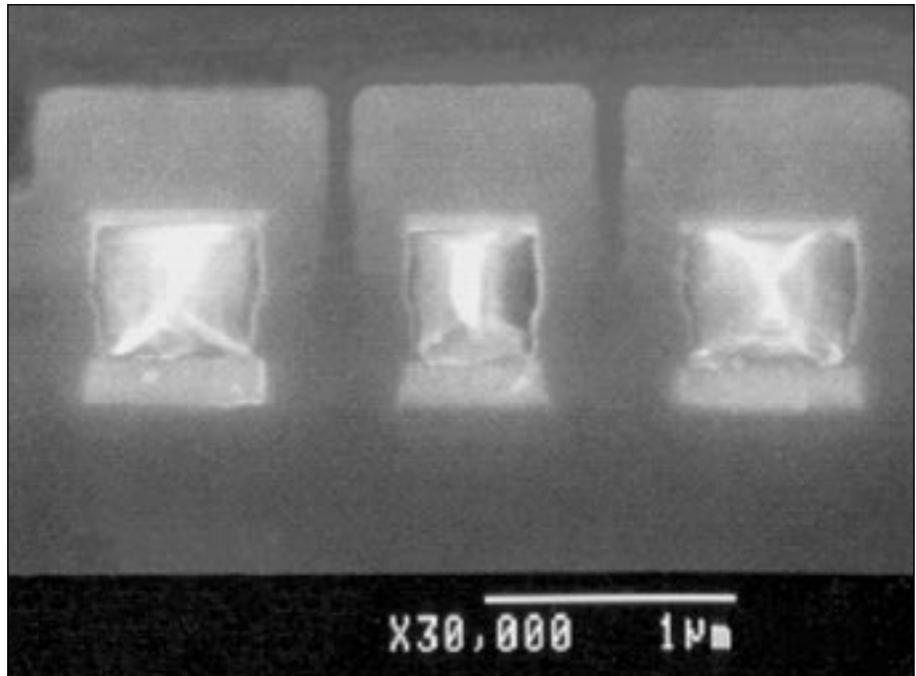
Refer to the Sales Specifications for these products.

PACKAGING

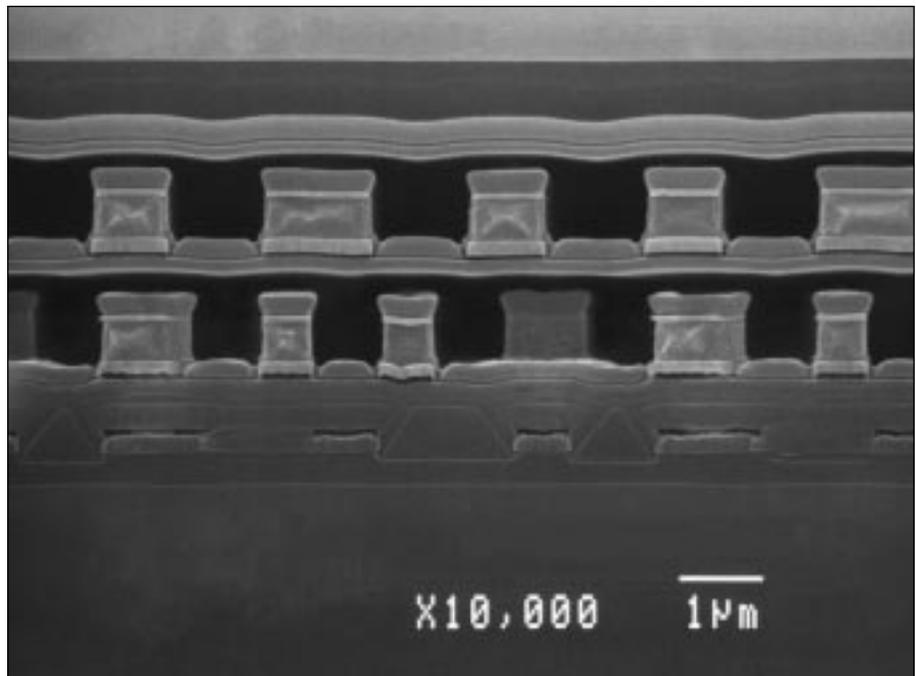
FOx Flowable Oxide is available in 125-, 250-, and 500-mL and 1-L (4- and 8-fl oz, 1-pt, and 1-qt) containers.

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;

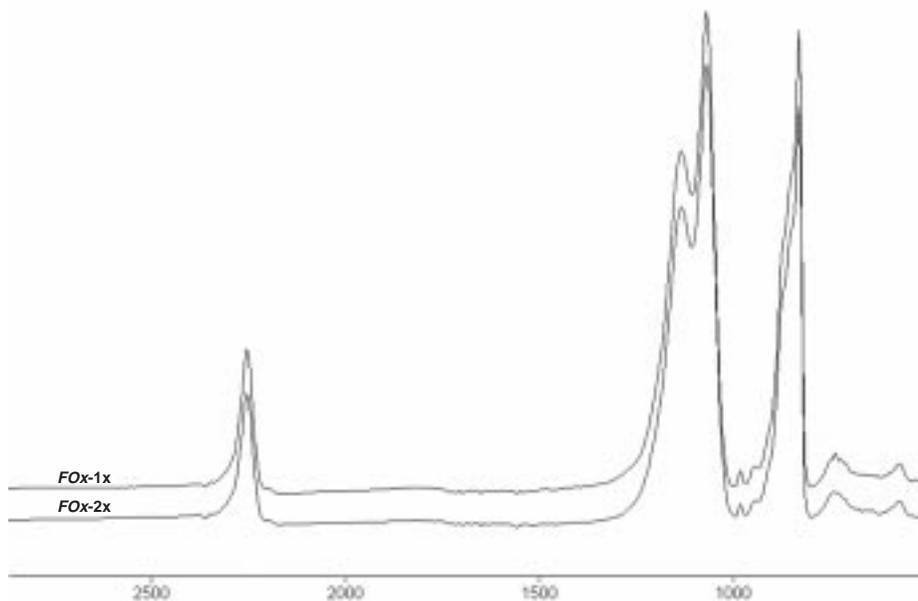


SEM cross-section of FOx Flowable Oxide gap fill capability with 800Å gap outlined.



SEM cross-section of FOx Flowable Oxide in three-layer structure.

FIGURE 1: Final Cured Film Characteristics, Measured by FTIR¹



¹Processed 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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