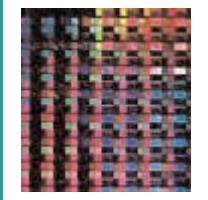


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DIELECTRIC MATERIALS IN SEMICONDUCTOR DEVICES TO THE SUB-0.10-MICRON DESIGN RULE

Completely revised and updated second edition
of a groundbreaking study on semiconductor
dielectrics - part of Kline's series on
Emerging Electronic Technologies

All semiconductor dielectrics are analyzed, but with
a special focus on low-k dielectrics for the
sub-0.18-micron design node



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Since the publication in 2000 of Kline's groundbreaking study titled **THE GLOBAL OUTLOOK FOR DIELECTRIC MATERIALS IN SEMICONDUCTOR DEVICES, 2000-2005**, much has already happened to warrant an update. And not just an update, but a whole new study. The market is developing inexorably according to the ITRS Roadmap schedule, and a few leading low-k candidates are coming into commercial focus. When the first dielectrics materials report was completed in early 2000, the commercial prospects for the dozen or so candidate low-k materials were still wide open to speculation.

Furthermore, the semiconductor market as a whole has entered a period of retrenchment following the slowdown in high-tech business that began in late 2000. Economists everywhere are scurrying to readjust their forecasts, and Kline is no exception. But in this case, Kline's new study, **DIELECTRIC MATERIALS IN SEMICONDUCTOR DEVICES TO THE SUB-0.10-MICRON DESIGN RULE**, addresses broader questions of importance to the dielectric-precursor market in particular, such as:

- Are the growth drivers for this market changing in light of the recent downturn?
- Just how "extendible" are organic and silico-organic low-k materials to the ultra-low-k range of less than 2.2?
- Who are the recent winners and losers in this market? Are there any new players on the scene?
- In light of recent economic developments and programmed delays in the ITRS Roadmap, what is the growth outlook for low-k dielectrics for 2001 to 2006?

DIELECTRIC MATERIALS IN SEMICONDUCTOR DEVICES TO THE SUB-0.10-MICRON DESIGN RULE provides answers to these questions. In this way, the report can help strategic planners involved in the supply of materials to semiconductor manufacturers to better understand the timing and impact of the inevitable change in semiconductor dielectric materials.

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The following is included for each material covered:

- An overview of the commercialization status
- A discussion of leading products and pricing
- Consumption estimates
- An assessment of major suppliers
- Outlook and forecast to 2006, with stretch estimates to the end of the decade

Other materials issues:

- Porosity builders
- Ancillary materials such as diluents, initiators used in deposition

6. MATERIALS SUPPLIERS

More than 20 suppliers are profiled in this chapter, including:

- Asahi Kasei
- HD Microsystems
- Honeywell
- Tokyo Ohka Kogyo
- Dow Corning
- Air Products/Schumacher
- Dow Chemical
- Hitachi

The following is included for each supplier:

- An overview of the company
- Products
- Affiliation and location
- Outlook

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OBJECTIVE

The service is designed to provide the global information and analysis that will enable strategic planners to effectively anticipate, plan, and respond to the evolution of the semiconductor device fabrication processes. Specifically, the report provides subscribers with the following benefits:

- An accurate prediction of the commercial impact and timing of new dielectric technology as well as conventional dielectrics in each major semiconductor market segment
- Profiles of dielectric material suppliers, including a discussion of their technology and the possibility for acquisition/alliance
- Identification of opportunities for related materials and equipment, including chemical vapor deposition (CVD) and spin-on equipment

STUDY DESCRIPTION

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includes nearly 200 pages of text and analysis, organized by the following major topics:

1. **Technical overview** of semiconductor fabrication processes as they pertain to dielectrics.
2. **Detailed projection of dielectric depositions**, by type of semiconductor (over a dozen categories, including microprocessors, digital signal processors, memory and more), with attention to the different integration schemes that will be employed (particularly dual-damascene copper).

3. **Market projection by type of dielectric**, including conventional silicon dioxide films as well as various type of capping, masking and etch-stop layers, passivation layers, and of course, low-k interlayer dielectrics (ILD).

DIELECTRIC MATERIALS

The semiconductor industry is quickly approaching a point at which conventional silicon dioxide dielectrics are inadequate for the job for which they are intended: insulating metal interconnects in ever-increasing scale of integration, and increased speed as well. The problem lies in the resistance-capacitance delay (RC delay), a physical fact of life resulting in increased capacitance as the wires crowd closer together and slow down processing. What is needed is an insulator with a lower dielectric constant than the value of 4.2, also expressed as k value, for silicon dioxide.

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looks at the total market for dielectrics in so-called "back-end-of-the-line" (BEOL) fabrication. This includes premetal, interconnect, hard mask, etch-stop, and final passivation layers. These are all insulation layers of varying thickness, and which perform different functions.

Although Kline's first dielectrics report studied the entire market for dielectrics, it devoted much of its attention to the burgeoning low-k market. This market is segmented as shown in Table 1, which identifies some of the current candidate materials that are commercially available or under development.

Table 1**CLASSIFICATIONS OF DIELECTRICS AND ANCILLARY MATERIALS**

Function	Material class	Materials	
		CVD	Spin-on
Premetal	Inorganics	BPSG	-
Interlayer dielectric (ILD)	Inorganics	SiO ₂ , FSG	-
	Organics	PTFE, FLAC	Polyphenylene, polyarylene, PTFE, others
	Silico-organics	SiOC	HSQ, SOG, silsesquioxanes, siloxanes, others
Cap/hard mask/etch stop layers	Inorganics	SiN _x , others	-
	Organics	-	-
	Silico-organics	SiC	Proprietary polymers
Passivation	Organics	-	Polyimide
	Silico-organics	-	BCB
Ancillary chemicals	Diluent gases	Ar, He, others	-
	Dopants	Phosphine, diborane	-
	Porosity builders	-	Norbornenes, other dendrimers, surfactants
	Co-reactants	Hydrogen peroxide, ammonia, oxygen, others	-
	Other	-	Initiators

RESEARCH METHODOLOGY

Kline employed a rigorous research methodology for this study in order to gather, analyze, and confirm the data required to construct a comprehensive report. This includes:

- **Primary field interviews**
The foundation of information and insights needed to complete this analysis has been developed through an extensive series of field interviews worldwide with key industry participants, including leading electronic device and semiconductor manufacturers, dielectric material suppliers, and pertinent government agencies, industry associations, and relevant trade factors.
- **Data analysis**
Technology, economic, market, and supply factors has been analyzed to assess the current industry structure and to project the demand for low-k dielectric materials to 2006.

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is available only by subscription. In order to maximize its usefulness to each subscriber, the following privileges and services will be made available:

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Since its inception in 1959, Kline has earned a reputation for delivering high-quality studies and market and technology assessments. We complete approximately 200 proprietary assignments and publish approximately 20 multiclient research reports each year. Over the last ten years, Kline has completed more than 50 projects related to electronic materials and technologies. Many of these assignments have investigated the market opportunities for new technologies with various performance capabilities. Other projects have evaluated new market opportunities for companies considering entering the electronics industry and have assisted suppliers of electronic raw materials in identifying future material needs.

In addition to studies on dielectrics, Kline has undertaken related studies into CMP technology and materials, which analyze the market for CMP slurries, pads, brushes, filters, and other materials. The first edition of **THE GLOBAL OUTLOOK FOR CHEMICAL MECHANICAL PLANARIZATION TECHNOLOGY AND MATERIALS** covered the forecast period of 1998 to 2003. A completely revised and expanded edition of this study covering the 2000 to 2005 period is now available. Kline is also undertaking a study related to resist, etch, and clean materials, as well as a fourth study in this series, on metallization precursors, both of which are scheduled for release very soon.

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