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Final Report (4Q 2001)

Task Title:	Sematech Interaction
Quarter:	Q4 FY01
Lead Center:	JPL
Program Area:	NEPP/EPAR
Task Manager:	Dr. Patrick Smith

Task Description

Sematech Interaction

- Disseminate knowledge throughout NASA of the major trends in the structure and potential reliability performance of advanced semiconductor devices.
- Improve NASA Failure Analysis capabilities by adopting the most recent advances in the semiconductor industry.

Goals/Objectives

Sematech Interaction

- Attend Sematech meetings and review publications of Sematech and Sematech member companies to determine major trends in semiconductor product development and failure analysis.
- Evaluate the potential reliability implications of major semiconductor trends for NASA programs.
- Encourage the NASA evaluation of advanced devices offering potential reliability improvements.
- Introduce state-of-the-art failure analysis techniques to NASA.

Report on Sematech Analytical Lab Mangers' Council Meeting

Patrick Smith

Meeting: Sematech Analytical Lab Mangers' Council Meeting
Place: International Sematech , Austin ,Texas
Dates: Sept 6-7, 2001

Introduction

The Sematech Analytical Lab Managers' Council is a group of managers from the analytical departments at the member companies of International Sematech that conducts 3 or 4 meetings per year on developments of analytical techniques and procedures applicable to the semiconductor industry. The meetings provide a forum where member companies, suppliers of analytical instruments, semiconductor equipment manufacturers, and government and academic researchers can present the analytical needs of the semiconductor industry, develop strategies for meeting these needs, and report progress toward meeting those needs.

The semiconductor industry is the largest and most sophisticated user of analytical instruments. The semiconductor industry defines the most rigorous analytical requirements in terms of spatial resolution, sensitivity, reliability, and specimen handling. The Lab Managers' council thus serves as the most important exchange between producers and users of analytical instruments, and is the best means for maintaining awareness of present and future analytical developments.

The awareness of the most recent developments in microanalysis is important for NASA in both realizing the technical demands it will face in the near future and in planning the facilities required to analyze the devices used in future missions. The Analytical Lab Managers' Council deals with measurement requirements of devices now in the development stage, so attendance at these meetings provides NASA the lead-time to obtain the necessary facilities to meet mission requirements. The knowledge acquired through the Sematech meetings is providing guidance to the JPL Reliability and Failure Analysis Group in our planned acquisition of a Scanning Electron Microscope and a Focused Ion Beam System.

September 2001Analytical Lab Managers' Council Meeting Agenda

Three major analytical areas were the focus of the September meeting:
- Scanning Electron Microscopy
- Analysis of Organic Particles
- Detection and Analysis of Airborne Molecular Contamination

Scanning Electron Microscopy

The major driving force for developments in scanning electron microscopy (SEM) is the decreasing feature size of semiconductor devices, which requires SEMs to operate at higher magnifications, higher resolutions, and lower accelerating voltages. In Fig 1 Bryan Tracey of the AMD Technology Research Group estimates the magnification needed to analyze semiconductor devices as a function of design rule. Lower accelerating voltages are needed to obtain more surface-sensitive contrast and to eliminate the need for coating samples, even though resolution decreases with lower accelerating voltages. High resolution instruments (~ 0.5 nm) require specimens to be located within the objective lens, and the instruments must have TEM-type specimen stage stability, vibration-free high vacuum systems, and extremely well-controlled environmental conditions. High resolution SEMs are expensive.

A second consequence of the decreased feature size is the requirement to locate and identify smaller particles which can cause yield and reliability problems. Since the size of problem-causing defects is in the tens of nanometers range, electron beam instruments are needed for particle analysis. In order to obtain location and identification of a statiscally significant number of small defects, defect review SEMs require automated sample handling of whole wafers. Multiple imaging techniques involving secondary electrons, backscattered electrons, and specimen current imaging are needed to classify the size, shape, and location of defects. Automated Energy Dispersive Analysis (EDA) is needed for elemental identification of the defects.

The use of multiple imaging modes in defect review tools is leading to the use of multiple imaging modes in SEMs for lab use. In our evaluation of SEMs for the JPL Failure Analysis Laboratory we have evaluated several instruments that provide improved imaging through the use of multiple detectors. A second requirement for SEMs, improved resolution in EDA, will be covered in future meetings, and will probably influence our lab SEM facilities within the next one or two years.

Analysis of Organic Particles

The main method for identification of small organic particles is small area infrared spectroscopy. FTIR (Fourier Transform Infrared Spectroscopy) is wavelength-limited to identification of particles in the 10µm range. Raman spectroscopy, using visible or near UV radiation, is theoretically able to analyze smaller particles. However, Raman spectroscopy is limited by the weakness of the Raman effect, and the small number of compounds that are Raman active.

Detection and Analysis of Airborne Molecular Contamination

Semiconductor fabs have typically had extensive facilities devoted to eliminating particulate contamination. The sensitivity of photoresists to ppb levels of airborne molecular contamination (AMC) is leading to increased efforts to detect and eliminate AMC. AMC arises from construction materials, such as paint, ceiling tiles, floor tiles, from cleanroom consumables, such as gloves, masks, boots, etc., and from cleanroom processing. Presently available detection systems for AMC were described, and several promising detection methods, based on military systems, were proposed.

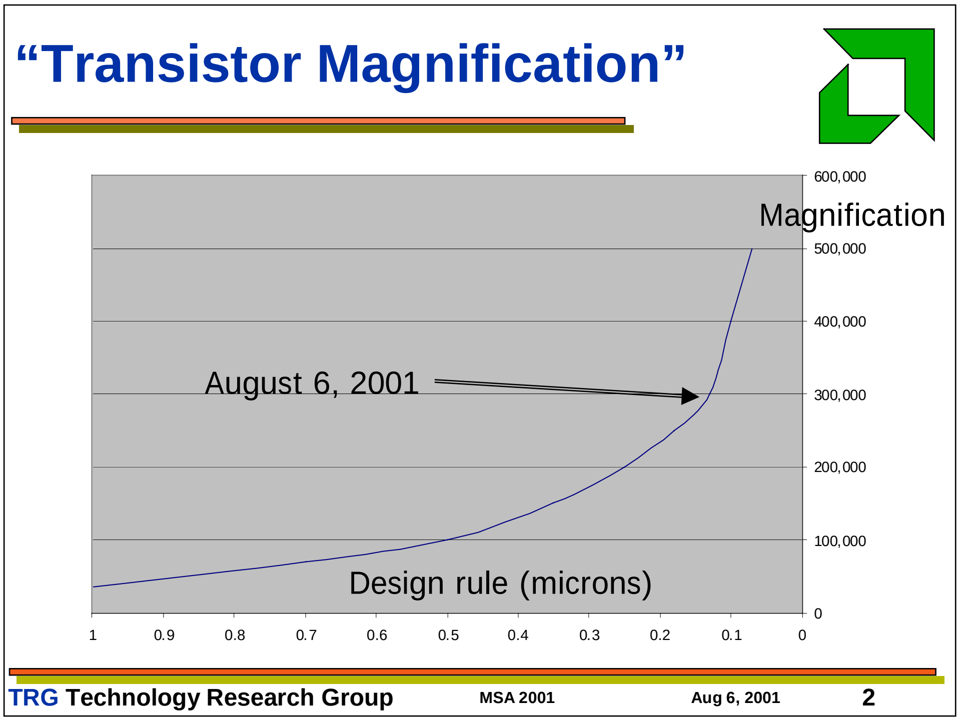

Fig. 1 Estimate of the magnification needed to analyze semiconductor device features as a function of design rule. (Courtesy of Bryan Tracey, Advanced Micro Devices)