

## ~ Author's Note ~

In 1967, Fairchild Semiconductor was an exciting place to learn. Semiconductors were largely discrete. Integrated circuit transistor and resistor elements were readily identifiable under low magnification. The laboratory where I was introduced to failure analysis consisted of a curve tracer, optical microscopes, and metallurgical cross sectioning equipment.

Failure analysis was both easier and harder than it is today. It was easier because devices performed simpler functions and most defects were mechanical and readily visible. It was harder because the physics behind many mechanisms was unknown. PNP transistors were prone to channel. NPN transistors sometimes failed with similar characteristics, but the physics proposed to explain one could not explain the other. It was uncertain why transistor gain decreased, why metal lines opened, and why power devices destroyed themselves in dramatic fashion. At the same time, the ambitious space program injected difficult reliability demands and quality requirements.

The annual Reliability Physics Symposium (now IRPS) became the preeminent forum for engineers to explain failure mechanisms and introduce new tools, such as the scanning electron microscope.

Since that time, countless books and periodicals have addressed semiconductor technology, but only a handful of books and an occasional magazine article are dedicated to failure analysis. Available failure analysis books focus on the power and limitations of failure analysis tools and techniques.

Unlike other failure analysis books, *Wafer Failure Analysis for Yield Enhancement* uses numerous examples to illustrate mechanisms and analysis. Writing from the analyst's point of view adds an element missing from available literature. It shows how an analyst must think, what questions he should ask, and how to approach a new problem. For an analyst, theory underlying electrical overstress, ESD, electromigration, and other mechanisms is important, but most important is how observable characteristics can be used to distinguish one mechanism from the other. A product engineer needs to judge whether Energy Dispersive Spectroscopy (EDS) results support conclusions claimed by an analyst more than he needs to know the optimum sensitivity of EDS. A customer surprised by a reliability setback faces a real problem, where time is critical and the stakes are high. He has neither time nor inclination to explore analysis issues as an academic subject. He needs to follow the analysis procedure, understand and act on results, and approve the best possible corrective actions. Each of the persons described may represent different companies involved in a mutual reliability problem. The future of their companies could depend on their cooperation and success at finding, recognizing, and implementing effective action.

Through examples, this book describes a powerful analysis approach refined through twenty-plus years of application. The approach that guides the analysis process remains valid and is even more important

today because problems are more complex. This approach provides the structure required to recognize information missing from volumes of data associated with incomprehensibly complex products. Key understanding can be provided by simple, often forgotten techniques, as well as by new diagnostic tests.

Failure analysis today is often a joint project involving several companies. To resolve critical situations quickly, everyone in the chain should understand the analysis approach and contribute information uniquely available from his perspective.

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\* This book is updated periodically to incorporate new failure analysis tools and to show their application in the failure analysis process.