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The Impact of New Process Control on Pattern Limited Yield: Enabling Technology Leaders to Become Low-Cost Producers

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At the 90nm technology node and beyond, pattern limited yield is becoming one of the most important economic issues in semiconductor manufacturing. The interaction of complex designs, aggressive resolution enhancement technology, and shrinking process windows is making common problems, such as CD and overlay control, progressively more difficult. Yield is increasingly impacted by hidden systematic error that is unobservable, unsampled, unmodeled, or uncorrectable using traditional metrology and process tools. Predictive CD and overlay yield models, calibrated with actual factory data, show rapid deterioration of next-generation ramp capability if the problem of hidden systematic error is not addressed.

In this work, we show that new process control approaches incorporating spectroscopic ellipsometry (SE), line-end shortening (LES), and advanced imaging (AIM) overlay metrology can unmask and enable correction of previously hidden error. Due to a phenomenon called metrology convergence, the incremental investment for these technologies is very low in comparison to the yield-dollar value returned. In fact, our models indicate that the percent of capital expenditure dedicated to metrology and process control must increase in order to minimize factory die cost. Our benchmark studies indicate that the early adopters of the new process control systems are margin-oriented technology leaders that are striving to become low-cost producers.

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