

Imec evaluates replacement metal gate options for further transistor scaling

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Imec is successfully testing and evaluating various options for further transistor scaling using high-k dielectrics and metal gates in a replacement metal gate (RMG) integration schema. Although RMG technology is inherently more complex than gate-first integration, it has a number of advantages that allow increasing the device performance and that widen the choices in terms of high-k and metal gate materials. Testifying to its progress with RMG, imec presented a number of noted papers at the 2012 VLSI Technology Symposium (June 12-15, 2012, Honolulu, USA).

One of the current challenges to enable further device scaling is the choice of [gate dielectric](#) and gate electrode. For the selection of the gate electrode, the key parameters to consider are the work function, [resistivity](#) and compatibility with CMOS technology. Further scaling also requires continued improvement of the channel mobility, adding the options for improved [stress management](#) and also reliability control as a first-order consideration in the choice of materials and processes.

In the industry, the RMG approach is rapidly becoming the integration scheme of choice, and an alternative for the gate-first approach. In RMG, the high-k gate dielectric is deposited in the beginning of the flow or just prior to gate electrode [deposition](#) and the gate electrode is deposited after the formation of the [junctions](#).

A clear advantage is the enhancement of the channel stress in shorter devices because of the dummy-gate removal, an intrinsic step in RMG

flow. RMG also allows metal gate processes with a lower thermal-budget, which broadens the range of material options for work-function tuning and reliability control. Additional advantages are a lower gate resistance compared to gate-first, important for RF CMOS, and more room for mobility improvement.

Imec and its partners have had an important role in the introduction of high-k metal gate processes, building a strong expertise and track record. With the eye on further scaling to sub-20nm technology nodes, we are now evaluating RMG technology for different application, looking at different integration options, materials selection and engineering, and compatibility with advanced modules and device architectures, for which we collaborate with the major tool suppliers. For our partners, we conduct fair comparisons of options, and in-depth understanding of the physical mechanisms and techniques involved, and the chance to explore the limits in performance and reliability.

The research is performed in cooperation with [imec](#)'s key partners in its core CMOS programs Globalfoundries, INTEL, Micron, Panasonic, Samsung, TSMC, Elpida, SK hynix, Fujitsu and Sony.

Provided by IMEC

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