

CMOS++: Opportunities for magnetic materials in on-chip power management

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Abstract

As Moore's law scaling comes to an end and technology advancement can no longer be achieved through the simple scaling of CMOS transistors, new opportunities will exist to exploit new on-chip materials to extend CMOS functionality outside of the investment in transistors. Power delivery presents increasing challenges for future multicore processors and unique opportunities for the introduction of magnetic materials in new passive devices. Future multicore processors will require hundreds of separate voltage domains, each operating at a different supply. Chips will still demand > 150 W of power while operating at typical supply voltages of less than 0.5 V, requiring in excess of 300 A of current. All of these requirements demand on-chip dc-dc conversion, allowing power to be delivered to the chip at high voltages and allowing individual cores to be voltage regulated to different supplies. On-chip dc-dc conversion requires large on-chip energy density storage. In this talk, I will contrast electrical and magnetic energy possibilities and make the case for magnetic energy storage with magnetic-core toroidal inductors. Magnetic materials, in the form of GMR sensors and magnetic tunnel junctions, also have a role in enabling high-efficiency, high-gain power-supply current monitoring. These new devices will have dramatic effects on how on-chip power management and delivery is performed in computing systems. On-chip power management architectures also represent an interesting, early application for 3D technologies.