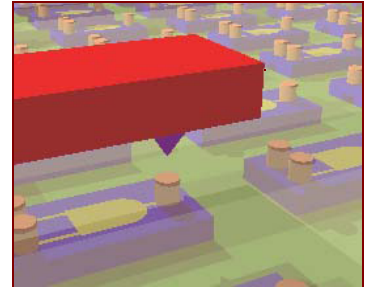


Center for Memory Intensive Self-Configuring Integrated Circuits (MISCIC Center)

As the scaling of Integrated Circuits (ICs) reaches its physical limits with CMOS, the phenomenal progress that has fulfilled Moore's Law will slow down as well. Already one can see that industry has been slower to move to new technology nodes due to the extraordinary cost of development and the limited benefit that is derived from it. The design community also has been reluctant to initiate new designs with application-specific customization due to the exorbitant cost of design, verification and re-spins (masks, etc.) in nanoscale CMOS. This is of concern for many applications, where the extremely high performance that is often attainable with hardware customization is not even offered commercially due to the impractical costs associated with application-specific ICs (ASICs) designed at low volumes. While research continues to extend Moore's law, it is apparent that for future ICs to be dominant drivers of technology and economic development we will require "More than Moore". Great opportunities exist to integrate functionality that is not possible today. Notable for our center activities, important emerging technologies include three-dimensional vertical stacking, hybridization of heterogeneous electronic technologies, incorporation of new multifunctional materials, and the inclusion of N/MEMS devices in the IC layer stack that can be used for post-manufacturing configuration.



In the MISCIC Center, we are working to advance the state of the art in the integration and interaction of N/MEMS devices with ICs via functional integration with CMOS, and by manipulation of materials that can be altered by currents and fields. Our efforts focus on the integration of N/MEMS probes with ICs. These probes provide the capability of having one device (the probe) interact with many points on the IC to effect change in the electronic circuit. Our application driver in this area is configurable RF circuit elements based on incorporation of resistance change materials. This particular application defines the specifications required for the integrated resistive-change materials at high frequency, particularly low resistance during the ON state and low parasitic capacitance during the OFF state. The companion need for low parasitic capacitance to ground in the RF IC forces the integration of N/MEMS probes with ICs to implement the reconfiguration capability. Additional applications of the N/MEMS probe array include network routing that provides on-demand configuring of communication channels and power switching within a multi-core IC that provides rebalancing of power delivery/storage.

Other efforts at Carnegie Mellon have previously developed CMOS-integrated microresonator systems and tunable capacitor RF ICs. To merge these technologies into self-configuring MISCIC systems, we are working to develop new nanofabricated materials that are readily integrated into RF systems. This we expect will lead to highly manufacturable RF ICs that merge ultra-high-Q resonant filters with reconfigurable capacitors and inductors.

Result from this center include unique N/MEMS devices that can be navigated and positioned with nanometer precision and accuracy. These devices will provide low resistance reliable contact and 10's of mA current drive to nanoscale pads on ICs. Such N/MEMS devices will facilitate manipulation within and among stacked silicon layers to enable a variety of applications. This realization of MISCICs will provide new capabilities to ICs that include: 1) reconfigurability and retasking, 2) fault tolerance and repair, and 3) performance targets and functions that are otherwise unattainable.

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