

# Hybrid semiconductor/molecular integrated circuits: Prospects and problems

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I will review the recent work on devices and architectures for future hybrid semiconductor/molecular integrated circuits, in particular those of "CMOL" (a combination of CMOS, complimentary-symmetry metal-oxide semiconductor, and MOLEcular) variety. Such circuits would combine an advanced CMOS subsystem fabricated by the usual lithographic patterning, a few layers of parallel nanowires formed by nanoimprinting, and finally a level of molecular devices that would self-assemble on the nanowires from solution. The CMOL concept enables a combination of the advantages of its components (e.g., reliability of silicon metal-oxide semiconductor field effect transistors (MOSFETs) and minuscule footprint of molecular devices), as well as those of patterning techniques: the flexibility of the usual lithography and the potentially low cost of nanoimprinting and chemically-directed self-assembly. This powerful combination may allow CMOL circuits to reach an unparalleled potential density (up to  $10^{12}$  functions per  $\text{cm}^2$ ) and ultrahigh rate of information processing (up to  $10^{20}$  operations per second on a single chip), at acceptable power dissipation (below  $100 \text{ W/cm}^2$ ). The main challenges on the way toward this goal include the development of reliable chemically-directed self-assembly of mid-size (3 nm-scale) molecules and of advanced fault-tolerant architectures for digital and mixed-signal CMOL circuits.

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