Magnetically Assisted Statistical Assembly of III-V Devices on CMOS

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We are researching an efficient process for integrating III-V devices on silicon CMOS using fluidic self-assembly and a unique magnetic retention mechanism. Specifically, III-V devices and silicon ICs will first be processed separately. Dielectric recesses 5 to 6 microns deep and 50 to 60 microns in diameter will then be formed on the IC wafer surface, and permanent ferromagnetic films will be deposited and patterned at the bottoms of these recesses. The III-V devices will be etched into similarly sized pillars that will then be embedded in a polymer, and the substrate will be removed. A permeable ferromagnetic film will next be patterned on the back side of the devices, and they will be released from the polymer. The resulting pills will be cascaded over the CMOS wafer in a fluid, where they will fall into the recesses and be retained by short-range magnetic forces. They will finally be bonded in place and interconnected with the underlying electronic circuitry, using techniques developed in our earlier integration research.

We have demonstrated experimentally that the proposed magnetic retention works and that pills formed, as just described are attracted to and held by patterned magnetized films [1]. We have also conducted fluidic assembly experiments in which thousands of 45 µ diameter, 6 micron thick III-V pills are flowed over a target substrate containing hundreds of correspondingly sized dielectric recesses in the apparatus shown in Figure 1. Initial fluidic assembly experiments without magnetic retention show that a large number of pills can be successfully assembled, as shown in Figure 2, but it is also found that the pills readily come out of the recesses when, for example, the substrate is removed from the fluid. This clearly demonstrates that a short-range retention force is essential to a practical self-assembly process, and in the near future, we hope to demonstrate high yield assembly and retention using magnetic attraction.

REFERENCES: