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Hybrid IC / Microfluidic Chips for the Manipulation of Biological Cells[1]

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A hybrid IC / Microfluidic chip that can manipulate individual biological cells in a fluid with microscopic resolution has been demonstrated. The chip starts with a custom-designed silicon integrated circuit (IC) produced in a foundry using standard processing techniques. A microfluidic chamber is then fabricated on top of the IC to provide a biocompatible environment. The motion of biological cells in the chamber is controlled using a two-dimensional array of micro-scale electromagnets in the IC that generate spatially patterned magnetic fields. A local peak in the magnetic field amplitude will trap a magnetic bead and an attached cell; by moving the peak's location, the bead-bound cell can be moved to any position on the chip surface above the array. By generating multiple peaks, many cells can be moved independently along separate paths, allowing many different manipulations of individual cells. The hybrid IC / Microfluidic chip can be used, for example, to sort cells or to assemble tissue on micrometer length scales. To prove the concept, an IC / Microfluidic chip was fabricated, based on a custom-designed IC that contained a two-dimensional microcoil array with integrated current sources and control circuits. The chip was tested by trapping and moving biological cells tagged with magnetic beads inside the microfluidic chamber over the array. By combining the power of silicon technology with the biocompatibility of microfluidics, IC / Microfluidic chips will make new types of investigations possible in biological and biomedical studies.

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