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Height Reduction of Magnetic Elements to Accelerate Magnetic Element Chip Production

Mechanotransduction comprises the conversion of mechanical forces into a cellular event. It has been shown that cell polarity of cortical neurons can be influenced with the use of nanoscaled mechanical forces. These forces are created with the use of a magnetic gradient produced by the deformation of the magnetic field by micro-scale magnetic elements on a chip, and ferromagnetic nanoparticles or microparticles that are inserted into the cells. The purpose of my research is to optimize the placement and geometric shape of soft iron microstructures on chip, which we call magnetic elements, so that the elements can be shortened, reducing the amount of time to produce a chip, along with reducing the cost per chip. The rate for the 80/20 Nickel-Iron material that is currently being used for the magnetic elements is deposited as a constant rate of 1.6 Angstroms per second, so reducing the height is the best way to speed up production. To optimize the dimensions of the magnetic elements we developed a method to simulate the magnetic field gradient in a program called COMSOL, in order to see the force plot generated by the configuration. Based on static magnetic field simulations with an external 150mT magnetic field, we found that 4µm x 8µm x 6µm (length, width, height) magnetic element generates a magnetic flux gradient with peak values of .2 kg/(m*s^2*A) near the elements. Electroplating 80/20 Nickel-Iron on glass substrates confirmed a deposition rate of 1.2 Angstroms per second. Reducing the height of magnetic elements expedite the process of chip fabrication and increase material stability, allowing for more experiments to happen at a faster rate. Furthermore, an optimized design can allow the scaling down of the chip design, allowing for subcellular manipulation.

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