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Orchestrating cells on a chip employing standing surface acoustic waves towards neural networks

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We propose the implementation of a new lab-on-a-chip based system for the controlled growth and formation of complex neural networks on a semiconductor chip. By combining microfluidic techniques with surface acoustic waves (SAW), we can create and stimulate simple life-on-a-chip systems. For this purpose, we constructed a chip consisting of a piezoelectric $LiNbO_3$ substrate and four interdigital transducers for the excitation of SAW to from standing waves with according nodes and antinodes in a checkerboard pattern. The anticipated formation of the pressure node lattice has been visualized using atomic force microscopy. By adding a PDMS-microchannel, this equidistant and regular patterning lattice allows us to simultaneously control the position of objects in a liquid environment in space and time. The possibility and accuracy to pattern cell-sized single objects on these chips were validated by patterning small beads of different sizes. Ensuring the conditions for cell growth, we successfully demonstrate single cell alignment, their adhesion and growth within the well-defined pressure nodes on the chip. Finally, we verified the biocompatibility of SAW for primary neural cells. This gives us confidence that it will allow us to apply our technique to single neurons in the future.