Fifteen-picoNewton force detection from neural growth cones using nanowire arrays

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The mechanical interactions between living cells and their environment are tremendously dynamic at the sub-micrometer scale. Together with bio-chemical signaling, mechanical interactions play an important role for cell functions as well as for the interaction with the extra cellular matrix (ECM) and cell/cell communication. Therefore, suitable methods for studying such subtle mechanical systems are required. Arrays of elastomer micropillars can detect forces exerted by different types of cells like epithelial cells and fibroblasts [1]. These elastomer pillars may be too big to resolve spatially the forces exerted by growth cones. Indeed, growth cones probe their environment by sending out and withdrawing lamellipodia and filipodia that have dimensions below 100 nm. In a previous work, we have shown that neurons can grow on nanowire substrates [2]. Here, we show that free-standing monolithic GaP nanowires grown by MOVPE can be used as a substrate to measure forces of axonal growth cones with excellent resolution in time, space and force.
The nanowires were grown in a hexagonal array defined by Electron Beam Lithography with a wire-separation of 1 μm. The wires were fluorescently labeled and a nerve cell suspension was added onto the array. The nerve cells were allowed to grow on top of the nanowire array, adhering to the tips of the nanowires. The movements of the wire tips were monitored and recorded using confocal microscopy. From the analysis of the nanowire deflections, magnitudes and directions of the growth cone-generated forces could be extracted. Forces down to 15 pN could be detected on growth cone lamelipodia [3].

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