Fabrication of High-Aspect Ratio Vertical Silicon Nanowire Electrode Arrays for Brain-Machine Interfaces

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Abstract : Brain-machine interfaces (BMI) is a ground rich of exploration opportunities where manipulation of neural activity are used for interconnect with myriad form of external devices. These research and intensive development were evolved into various areas from medical field, gaming and entertainment industry till safety and security field. The technology were extended for neurological disorders therapy such as obsessive compulsive disorder and Parkinson's disease by introducing current pulses to specific region of the brain. Nonetheless, the work to develop a real-time observing, recording and altering of neural signal brain-machine interfaces system will require a significant amount of effort to overcome the obstacles in improving this system without delay in response. To date, feature size of interface devices and the density of the electrode population remain as a limitation in achieving seamless performance on BMI. Currently, the size of the BMI devices is ranging from 10 to 100 microns in terms of electrodes' diameters. Henceforth, to accommodate the single cell level precise monitoring, smaller and denser Nano-scaled nanowire electrode arrays are vital in fabrication. In this paper, we would like to showcase the fabrication of high aspect ratio of vertical silicon nanowire electrodes arrays using microelectromechanical system (MEMS) method. Nanofabrication of the nanowire electrodes involves in deep reactive ion etching, thermal oxide thinning, electron-beam lithography patterning, sputtering of metal targets and bottom anti-reflection coating (BARC) etch. Metallization on the nanowire electrode tip is a prominent process to optimize the nanowire electrical conductivity and this step remains a challenge during fabrication. Metal electrodes were lithographically defined and yet these metal contacts outline a size scale that is larger than nanometer-scale building blocks hence further limiting potential advantages. Therefore, we present an integrated contact solution that overcomes this size constraint through self-aligned Nickel silicidation process on the tip of vertical silicon nanowire electrodes. A 4 x 4 array of vertical silicon nanowires electrodes with the diameter of 290nm and height of 3µm has been successfully fabricated.

Keywords : brain-machine interfaces, microelectromechanical systems (MEMS), nanowire, nickel silicide
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