Contribution ID: **124** Type: **Oral Contribution**

High spatial resolution probes for neurobiology applications

Tuesday 2 September 2008 17:30 (20 minutes)

Position-sensitive biological neural networks, such as the brain and retina, require position-sensitive detection methods to identify, map and study their behaviour. Traditionally, planar microelectrodes have been employed to record the cells electrical activity, with device limitations arising from the electrodes 2-D nature. Described here is the development and characterisation of an array of electrically conductive micro-needles aimed at addressing the limitations of planar electrodes. The capability of this array to penetrate neural tissue improves the electrode-cell electrical interface and allows more complicated, 3-D networks of neurons, such as in the brain, to be studied. State-of-the-art semiconductor fabrication techniques were used to etch, passivate, conformally metal coat and fill high aspect ratio holes in silicon. These are subsequently transformed in to needles with conductive tips. This process has enabled the fabrication of arrays of unprecedented dimensions: 61 hexagonally close-packed electrodes, up to 150um tall, with 60um spacing. Electroplating the tungsten tips with platinum ensures suitable impedance values (˜300 kOhm at 1 kHz) for the recording of neuronal signals. Without compromising spatial resolution of the neuronal recordings, this array adds a new and exciting dimension to the study of biological neural networks.

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Session Classification: Position Sensitive Detectors for Biology

Track Classification: Position Sensitive Detectors for Biology