Fabrication of Nanoscale Metal Electrodes for Molecular Electronics

Technology #m05-093

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Self-aligning lithography method that creates nanoscale inter-electrode gaps for use in nano-electronic applications.

Conventional lithography patterning is utilized in a two-step process. In the first step, the electrode is formed by metal deposition onto the desired lithographically patterned scheme. A sacrificial layer of aluminum is then deposited on top of the electrode. The aluminum oxidizes in air creating a thin film of aluminum oxide that grows over the edge of the electrode. In the second step, another electrode is lithographically patterned, effectively overlapping the first electrode (still covered in oxide). The oxide overhang shields the space below it from the subsequent metal electrode deposition, creating a nanogap between the first and second electrode. The aluminum layer is removed leaving two electrodes spaced a few nanometers apart. The spacing is precisely controlled to the nanometer by the self-aligned overhang whose width depends on deposited aluminum thickness and oxidation.

Self-alignment through oxidation of sacrificial aluminum oxide layer ensures precise, high yield nanoscale gaps.

This invention has been demonstrated in several versatile nanotechnology applications. A single-molecule transistor has been created from this self-aligning lithography and self-assembly of functionalized molecules onto the electrodes and transistor gate. Electrical conductance has been measured through this system. Further, carbon nanotube electrodes separated by a nano-gap were also created from the self-alignment method.

The precise fabrication of sub-10 nm nanoscale gaps has been verified using electron microscopy.

Applications:

– Nanoscale electrodes for nanoelectronic devices
– Miniaturization of integrated circuits
– Electronic probing of molecular systems
– Self-assembly of molecular electronic devices
– Nano-biosensors and lab-on-a-chip

Advantages:

– Sub-10nm gap spacing is achievable enabling molecular electronics testing
– Nanometer gap control with conventional, high throughput lithographic techniques
– Low cost addition to conventional lithography methods
– Self-aligning method achieves precise control of gap spacing (1 nm)
– Modular manufacturing allows for specific electrode design

Patent information: ~ see link below ~

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Licensing Status: Available for licensing and sponsored research support

Related Publications:


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