

319f Controlled Fabrication of Nanometer Sized Gaps Using Magnetic Alignment of Nanowires

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The semiconductor industry has seen a remarkable miniaturization trend; molecular electronics that is making an information-processing device with a single molecule has received considerable attention recently in scientific and engineering communities. One of the major problems impeding the progress is the lack of reliable methods to interface a chemically synthesized structure to macroscopic electronic circuits. In its simplest realization, an electrical measurement requires the fabrication of metallic electrodes whose separation is comparable to the size of nanostructure itself, i.e. the gap between these electrodes should be in nanometer dimension. Early methods to produce nanogaps were complex and give a low yield. These include electron-beam (e-beam) lithography, break junctions, carbon nanorods, electrochemical growth, shadow evaporation, and electro-migration. In this paper, we present a simple, highly controllable and cost effective method to produce nanogaps of approximately 100 nm by magnetically assembling nanowires between the lithographically patterned nickel electrodes of 10 micrometer gap. Recently Hangarter C.H and Myung N.V have demonstrated assembling and positioning of nickel nanowires on ferromagnetic contacts using magnetic field. This magnetic assembly technique was shown to have high potential for high density interconnects. By controlling the length of nanowires we believe that nanogaps of less than 100 nm can be fabricated. The metallic nanowires were electrochemically grown using template synthesis. The lengths of the nanowires are controlled such that when magnetic assembly is done a nanogap is formed between the nanowire and the ferromagnetic pad. The presence of the nanogap was confirmed using scanning electron microscopy and electrical measurements. This fabrication technique which uses magnetic assembling of nanowires is simple, controllable, cost effective and robust, allowing rapid fabrication of electrode pairs of nanometer sized gaps with high yield. We expect the method to prove useful in interfacing molecular scale structures to macroscopic probes for sensing and other electronic applications.