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Aluminum Nanowire Arrays via Directed Assembly

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Vertically-oriented, lithographically-ordered, metal nanowire arrays have potential utility as capacitors, high surface area electrodes, electrochemical biosensors, optical nanoscopes, rectennas, and solar cells, but presently lack a route to fabrication. Template-based techniques, such as electrodeposition into lithographically-defined nanopore arrays, have produced well-ordered nanowire arrays with a maximum pitch of about 2 μm; such nanowires, however, tend to cluster due to local attractive forces. This complicates coating the nanowires with materials to produce core-shell or nanocoax structures for the above applications. Chemical vapor deposition has shown success in freestanding nanowire fabrication, but can only produce metal nanowires in disordered arrays or carbon nanofibers having low electrical conductivity (~104 S/m, three decades lower than good metals).

To realize the aforementioned applications, we have modified the preparation of AAO templates to produce highly ordered and freestanding aluminum nanowire arrays. This top-down process etches the nanowires from the underlying substrate at lithographically-defined locations, providing high control of the nanowire placement. Additionally, the process is amenable to low-cost, large-scale production because it is solution based, roll-to-roll compatible, operates at atmospheric pressure with temperatures between 0 0C and 60 0C, and uses Al, an earth abundant and inexpensive metal.