Transplanting Assembly of Single-strand Carbon Nanotubes
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Most of the potential applications of carbon nanotubes (CNTs) such as field emitters, scanning probe microscopy (SPM) tips, and nanowire interconnection require deterministic assembly techniques with control of shape (diameter and length), orientation, location, and range. We are developing a new deterministic assembly method for single strand CNTs such that the individual CNTs can be integrated into micro-scale devices. For this purpose, we propose and demonstrate a concept of transplanting assembly of individual CNTs. An array of nickel catalytic dots is seeded at the predefined locations on a titanium deposited silicon wafer using electron beam lithography followed by a metal liftoff process. An array of vertically aligned CNTs is grown from the Ni catalysts (Figure 1) using plasma enhanced chemical vapor deposition (PECVD) machine developed by Micro & Nano Systems Laboratory of MIT [1-2]. Each single strand CNT is embedded into polymer blocks, which work as CNT carriers. A 1.5-μm-thick positive photoresist is coated on the silicon wafer before 20-μm-thick negative photoresist (SU8 of MicroChem Corp.) is coated on top of it. The SU8 layer is patterned into cylindrical blocks. Finally, each SU8 block encapsulating one single-strand CNT is released by removing the positive photoresist layer (Figure 2). Each released SU-8 block can be transplanted to the location of interest using the assembly methods readily available at the micro scales.

![Figure 1: An array of vertically aligned single strand CNTs. CNTs were grown straight on the seeded area, and the enlarged view shows that each CNT has a uniform diameter from the top to the bottom.](image1)

![Figure 2: An SU8 block with a single CNT on one side. The length of the extruded CNT is 1.5μm, and this is the same as the thickness of the positive photoresist layer.](image2)

REFERENCES