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Fabrication of metal nano-wires using carbon nanotube masks

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Circumventing problems lying in the conventional lithographic techniques, we devised a new method for the fabrication of nanometer scale metal wires inspired by the unique characteristics of carbon nanotubes (CNTs). Since carbon nanotubes could act as masks when CNT-coated thin Au/Ti layer on a SiO_2 surface was physically etched by low energy argon ion bombardment (ion milling), Au/Ti nano-wires were successfully formed just below the CNTs exactly duplicating their lateral shapes. Cross-sectional analysis by transmission electron microscopy revealed that the edge of the metal wire was very sharply developed indicating the great difference in the milling rates between the CNTs and the metal layer as well as the good directionality of the ion milling. We could easily find a few nanometer-wide Au/Ti wires among the wires of various widths. After the formation of nano-wires, the CNTs could be pushed away from the metal nano-wire by atomic force microscopy. The lateral force for the removal of the CNTs are dependent upon the width and shape of the wires. Resistance of the metal nano-wires without the CNTs was also measured through the micro-contacts defined by electron beam lithography. Since this CNT-based lithographic technique is, in principle, applicable to any kinds of materials, it can be very useful in exploring the fields of nano-science and technology, especially when it is combined with the CNT manipulation techniques.