Si nanowire growth controlled by variable pressure

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Conventional top-down manufacturing for nanostructures are starting to approach fundamental physical limits for further shrinkage in size. New strategies, such as bottom-up approaches, are needed for meeting the demands of future nanoelectronics and computation. Bottom-up growth processes like carbon nanotubes, molecules and semiconductor nanowires have the potential to go far beyond the limitations of top-down fabrication. However, the growth of ordered nanowire arrays at a desired place and a desired length and diameter is still limited by today's understanding of the growth process.

We report a new growth process of Si nanowires via vapor-liquid-solid growth by reactive evaporation of silicon monoxide (SiO) and using gold nanodots for size and position control on silicon substrates. Early stages of the growth are reported. The influence of the variation of the nitrogen pressure, which is used as a transport gas for the SiO vapor, is demonstrated by SEM images. An increase in nitrogen pressure reduces the amount of wires grown, as can by seen in Fig. 1 to 3.

The dependence of the nanowire diameter on the size of the gold islands used for the growth will be discussed. In addition, nanowires that have been grown using a thin gold film on a silicon substrate show an oscillation in diameter. This effect has been reported before using a conventional CVD process (e.g. silane, silicon tetrachloride) for wire growth, and has been attributed to a self-oscillation process during vapor-liquid-solid growth (1, 2). The reactive evaporation process of SiO for the growth of the nanowires is confirmed by TEM images. Nanowires show an unusually thick oxide shell around the crystalline silicon wire core, which can be understood by the decomposition of SiO into silicon and silicon dioxide due to a phase separation process during the growth (3, 4).

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Fig. 1:

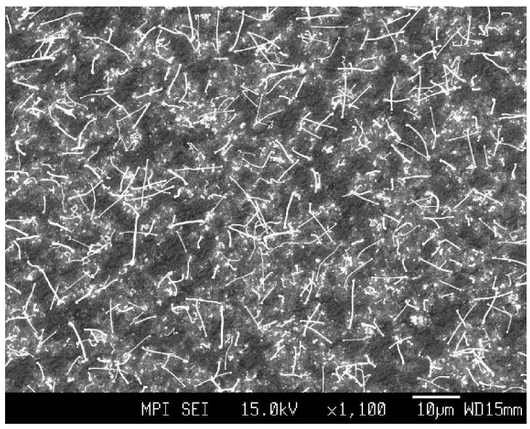

Fig. 2:

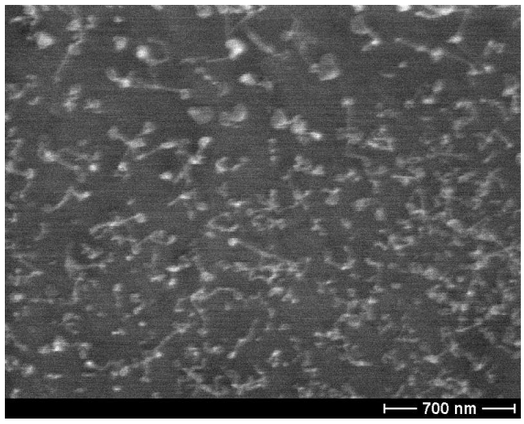

Fig. 3: