

PATTERNED GROWTH OF HIGHLY ALIGNED CARBON NANOTUBES ON SOL-GEL PREPARED SUBSTRATES

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Growth of carbon nanotubes (CNTs) in the patterned and aligned fashion is important for many of the proposed applications. Various techniques, such as photolithograph [1] and electron beam evaporation through shadow mask [2], have been used to create catalyst patterns for CVD (chemical vapor deposition) growth of patterned and aligned CNTs. However, these techniques require sophisticated and expensive facilities and are hard to scale-up.

Sol-gel method has been successfully adopted to prepare film-like iron/silica substrates for large-scale growth of highly aligned multi-walled carbon nanotube arrays [3-5]. Here, we report that by using TEM grids as shadow masks the sol-gel technique can be readily used to prepare patterned substrates to grow patterned carbon nanotube towers. The technique is briefly described as follows. A catalyst precursor solution is prepared by magnetic stirring a mixture of tetraethoxysilane (TEOS), nonionic triblock copolymer [Pluronic, P123($M_n=5800$), $\text{EO}_{20}\text{PO}_{70}\text{EO}_{20}$], iron nitrate, ethanol and water. A strip of silicon wafer coated with a thin silica layer was then dipped into the solution to coat a thin film on the wafer surface. Before gelation of the film, copper TEM grids with various kinds of openings, including square, hexagon, triangle, letters and numbers, were placed on the film to act as shadow masks, allowing nanotubes to grow out only from the open holes of the grids. After gelation, the gel, together the TEM grids, was dried overnight at 80 °C to remove the excess water and solvent, followed by calcination in a tube furnace at 450 °C for 10 h under vacuum condition and reduction at 500 °C in hydrogen. Subsequently, a flow of 10% acetylene in nitrogen was introduced into the reaction chamber at 650 °C, and carbon nanotubes grew out perpendicularly from the substrate located at the open parts of the TEM grids to form well-patterned nanotube towers. The towers are composed of highly aligned carbon nanotubes. By using TEM grids with different configuration of openings, we have obtained beautiful patterned nanotube towers with top view of square, hexagon, triangle, letters, numbers, etc. In comparison with other techniques, our method is simple, low cost and easy to scale-up.

References

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