catalyst layers and lead to the formation of intaglio-structured CNT array patterns. As the chemical masks of various materials can be facilely obtained through the micro-machining, this method brings a feasible route to control the nanoscale self-assembling of CNT structures. Based on this process, super-hydrophobic patterned CNT structures with a contact angle of 152o can be fabricated.

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Horizontally Aligned SWNT Growth on R-cut Crystal Quartz Substrates

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Orientation control of SWNTs is important for the fabrication of SWNT applications. Horizontally aligned SWNTs can be synthesized on specific substrates, such as sapphire and crystal quartz substrates, and ST-cut substrates are popularly used in the case of crystal quartz substrates. On ST-cut surfaces, SWNTs are grown along the direction of the x-axis, and the orientation is improved after the substrates are annealed at high temperature for an extended time. The orientation mechanism is understood by the atomic structure of the ST-cut surface. However, the ST-cut surface is complicated because it is an artificial surface. In this paper, we used R-cut ([101] face) substrates of crystal quartz for horizontal aligned growth of SWNTs. The [101] face is one of the stable surfaces that appear on natural quartz crystal, and it is closest to the structure of the ST-cut surface. Fe/Co metal nanoparticles supported on zeolite particles were used as catalyst. The zeolite particles were dispersed on the R-cut surface and SWNTs were synthesized by the alcohol catalytic CVD method. SEM and AFM observations revealed that SWNTs were grown along the direction of the x-axis on the R-cut surface without annealing treatment. On the R-cut surface, step and terrace structures appeared in AFM images. SWNTs were aligned in the terraced area, indicating that this surface structure aligned the SWNTs. We conclude that the ST-cut surface is a collective of small domains of [101] faces and the resulting alignment of SWNTs is owing to the [101] face structure.

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Growth of high-density vertically-aligned carbon nanotubes on conductive substrates by plasma-assisted catalyst pretreatments

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A plasma-assisted thermal pretreatment of Ni, Co, or Fe films facilitates the growth of high-density vertically-aligned arrays of small diameter carbon nanotubes on conductive materials such as TiN or doped mono- and poly-crystalline Si. The plasma-assisted pretreatment promotes stronger catalyst-support interactions than the purely-thermal pretreatment. This reduces catalyst mobility and hence stabilizes smaller catalyst particles with a higher number density. Purely-thermal catalyst pretreatment gives limited or no growth on these substrates.

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Synthesis of B-doped DWCNTs using catalytic reaction of triisopropyl borate

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Although CNTs have outstanding properties for applications such as electronic devices, field emitter, transparent conducting film, sensor, one of the greatest challenges, the tailoring of their electronic properties remains unfulfilled. In particular, the separation of metallic and semiconducting CNTs is still needed. One candidate method to tailor the electronic properties is to chemically modify the CNTs by substitution of the carbon atoms with the incorporation of heteroatom like boron into the carbon networks. B-doped CNTs all reveals a metallic behavior irrespective of diameter or chirality, because the substitution of boron atom in hexagonal carbon lattice gives rise to acceptor states near the Fermi level of the material. In this communication, we demonstrate the synthesis of high-quality B-doped DWCNTs by catalytic decomposition of tetrahydrofuran and triisopropyl borate over Fe-Mo/MgO catalyst at 900 ¡É. An overall observation in our products indicates that proportion of synthesized DWCNTs was approximately over 90 % and SWCNTs very few exist below 10 % in the as-grown carbon products. From XPS result, the B-C bonding in B1s signals provide evidence for highly coordinated boron atoms replacing carbon atoms within the graphite sheet. We obtained substituted boron concentration of 0.9 - 2.8 at.% according to increasing triisopropyl borate concentration of 20 - 60 %. We suggest that substituted boron concentration in the hexagonal carbon lattices can be easily controlled by concentration of triisopropyl borate. We designed flexible transparent conducting film using B-doped DWCNTs.

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Study of relationship between diameter of carbon nanotubes and surface morphology of Al2O3 supporting layer

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It is widely recognized that single-walled carbon nanotubes (SWNTs) has emerged as alternative material for next-generation electronics owing to extraordinary electrical properties associated with one-dimensional nature. Since the electronic properties of SWNTs depend on their geometrical structures such as chirality and diameter, controlling SWNTs diameter is thus considered as an ultimate goal for application of SWNTs-based nanoelectronics. It is well known that the SWNTs diameter can be influenced by a catalytic nanoparticle size. Here, we systemically investigated the relationship between the SWNTs diameter and surface morphology of Al2O3 supporting layer. The SWNTs were synthesized on a nanostructured catalytic layer consisting of Fe/Al2O3/Si substrate using a conventional thermal chemical vapor deposition system. The morphological and chemical features of Al2O3 layer and Fe catalytic nanoparticles were studied by atomic force microscopy, scanning electron microscopy (SEM), and X-ray photoelectron spectroscopy. The characterization of SWNTs was conducted by SEM and resonant Raman spectroscopy with excitation wavelengths of 514 nm (2.41 eV) and 633 nm (1.96 eV). As a result, the RMS roughness and grain size of Al2O3 layer can be controlled by adjusting thickness of Al layer. The agglomeration induced by surface diffusion of Fe catalytic nanoparticles can be governed by the structural modification of Al2O3 layer, which gives rise to change in SWNTs diameter. In the case of 15-nm-thick Al2O3 layer, the synthesis of SWNTs with an extremely narrow diameter distribution was achieved successfully.