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Influence of the nano-structure and composition of titanium nitride based substrate on the carbon nanotubes grown by CVD

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We present a study of the influence of the substrate nano-structure on the morphological properties of the carbon nanotubes (CNTs) by sequentially growing *in situ* the TiN_xO_y film, dispersed nickel catalyst particles, and CNTs. The results show that the stoichiometry and the nanostructures of the substrate intervene in the growing process. Non-stoichiometric TiN_xO_y thin films were grown on crystalline silicon by ion beam deposition at 500°C followed by *in situ* deposition of the catalyst nickel particles at 750°C. *In situ* XPS system allows compositional and structural analysis in all the growing stages of the samples. The stoichiometry of the TiN_xO_y substrates modifies the films properties as revealed by X-ray diffraction and nano-hardness measurements. The CNTs are grown immediately after the catalyst deposition by feeding acetylene gas and maintaining the substrate at 700°C. The quite aligned CNTs were studied by scanning and transmission electron microscopy techniques showing different population density, morphology, and diameter as a function of the O substrate content. The results show that O prevents the coarsening of the catalyst nickel particles, modifying the surface diffusion mobility of the precursor atoms involved in the nanotubes growth (Ostwald ripening).¹ The initial high population of relatively small catalyst nickel islands per unit of area is preserved leading to higher nanotubes density. Results showing the dependence of the size and density of the CNTs on the amount of O present in the substrate are reported and discussed. The experimental findings show that, besides acting as diffusion barrier between the catalyst particles and the silicon, the substrate also influences the kinetics of growth of carbon nanotubes.¹ Amana PB, Pint CL, McJilton L, Kim SM, Stach EA, Murray PT, et al., Nano Lett 2009;9(1):44-53.

Keywords

Nanostructured TiN_xO_y
Carbon nanotubes
Barrier (buffer) layer