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New insight into carbon nanotube synthesis from an original Pt/Ti alloy by catalytic chemical vapor deposition

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Abstract: Carbon nanotubes (CNT) represent an ideal one-dimensional object with unique properties among which electrical conductivity and mechanical ability. They are therefore a promising material for plenty of applications such as catalysis, sensors, electronics or renewable energies. Chemical vapor deposition (CVD) appears to be a promising, versatile technique for industrial synthesis and functionalization of carbon-based materials at low cost. The usual metallic catalysts employed for the synthesis of CNT are transition metals such as Co or Ni that are generally removed by etching before applicative processing.

In the present communication, we will detail results on multi-walled CNT synthesized by atmospheric pressure CVD from an original Pt/Ti alloy, resulting in high-yield nanotube formation.

CNT have been synthesized from a thin Ti/Pt bilayer deposited onto oxidized Si wafers using both physical vapor deposition and magnetron sputtering processes. Dewetting of the Pt film upon annealing at 1040°C in reductive H₂ atmosphere has been observed, leading to the formation of Pt/Ti alloy particles serving as catalytic sites where the high-yield growth of carbon nanotubes has taken place once CH₄ was introduced as carbon feedstock. This study aims to better understand the CNT formation mechanisms as well as lowering the platinum loading by decreasing the particle size and increasing the number of catalytic sites. The morphology, chemical composition and structural properties of the resulting Pt/Ti particles and associated CNT have been investigated by scanning and transmission electron microscopies and by Raman and energy dissipative X-ray spectroscopies. This quite general method for producing supported multi-walled carbon nanotubes/Pt composites opens interesting perspectives for their utilization as electrode in fuel cells or microbatteries.