Effect of tungsten/filament on the growth of carbon nanotubes in hot filament chemical
vapor deposition system

1. Introduction

In the recent years, novel carbon materials such as diamond thin films. diamond like carbon coatings, fullerene and carbon nanotubes have been intensively investigated because of their great potential applications. A variety of techniques have been developed for the synthesis of these novel carbon materials. Among them chemical vapor deposition (CVD) technique has been proven to be a very versatile tool. This technique is being used to synthesize highly oriented diamond thin films. fullerene. decorated and branched carbon nanotubes in the past [I-8]. The deposition of such complex structures has come up with several surprises including the carbon nano-onions [5]. single and multi-walled carbon nanotubes [I-16]. nano-homs [7] and carbon micro-trees [8-9]. The unique atomic structures have exhibited interesting electronic and mechanical properties arising frorn the reduced dimensionality. Beside the academic interest in nanoparticles. recent research is aimed towards the industrial applications such as use in cold-field electron emitters for 2-D display devices. X-ray generation and hydrogen storage materials [I0-12].

The final shape is mainly determined by two driving forces being: ti) preferential growth of the grapheme lattice planes and (ii) the tendency of graphene plane to bend. The non-thermal equilibnum conditions necessary for growth of carbon nanoparticles are usually established by arc discharge [13], laser ablation [14],pyrolysis and catalytic methods [I3-16]. Recently the use of plasma enhanced CVD and thermal CVD methods for synthesizing the nanopanicles are reported too [4, 9, I2, 16]. Growth of carbon nanotubes on catalyzed Si substrate in HFCVD system is also reported [17-21].

Various reports are available for the growth of single as well as multi-walled carbon nanotubes using HFCVD system but all the works are carried out using a single or multiple catalyst (Ni, Co, Fe, graphite fiber etc.) but as such no reports available for the in-process catalyst [22—26]. In the present work

a in-process catalyst (from the tungsten filament) is found to activate CNT growth. As such, to our knowledge, reports are not available for the use of W as catalyst. Although massive production of carbon nanotubes has been realized by arc discharge and laser ablation, controlling diameters, Length and preferable alignment of carbon nanotubes has never been easily possible with such approaches. Moreover, fabrication of carbon nanotubes on plain Si substrateis of technological importance for the application to future Si based optoelectronic devices.

ln this paper we present the synthesis of carbon nanootubes (wounded/noodle like shaped) on a plain silicon surface. without the use of a nucleation agent or external catalyst grown by hot tungsten filament chemical vapor deposition system with a gaseous mixture of CH_4 and H_3. In the present work, it is found that the tungsten from the hot filament work as catalyst. The results are discussed using the structural analysis carried out rising