LARGE-AREA HIGH-THROUGHPUT SYNTHESIS OF MONOLAYER GRAPHENE SHEET BY HOT FILAMENT THERMAL CHEMICAL VAPOR DEPOSITION

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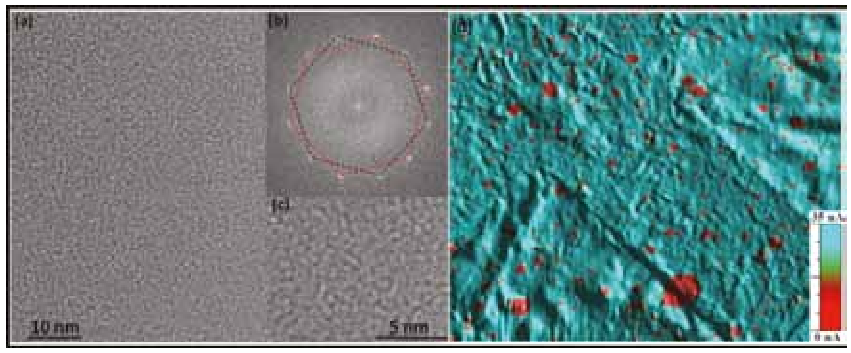

Graphene is considered as a promising electronic material in post silicon electronics. Due to the unusual physical and electronic properties, as well as excellent charge-carrier mobility, graphene quickly grabbed the attention of physicists and engineers; bringing a hope that one day it will compete with silicon to be the material of next generations for certain applications in the electronics industries. It is believed that the graphene based nanodevices can be easily extended to large-scale integration (in contrast to carbon nanotube electronics) and can rank among the most important achievements in nanoelectronics, possibly outweighing other alternatives such as molecular and nanotube electronics. Recently, Research Group at TEMA, University of Aveiro, developed new hybrid of Hot filament Thermal CVD (HFTCVD) as a new hybrid of Hot filament and Thermal CVD and demonstrate its feasibility by producing high quality large area strictly monolayer graphene films on Cu substrates. Gradient in gas composition and flow rate that arises due to smart placement of the substrate inside the Ta filament wound alumina tube accompanied by radical formation on Ta due to precracking coupled with substrate mediated physicochemical processes like diffusion, polymerization etc., led to graphene growth. Figure (1) describes the graphene growth and detailed XPS study. Figure (2) depicts the High-resolution TEM image and local electronic properties of transferred graphene sheets by C-AFM, respectively.

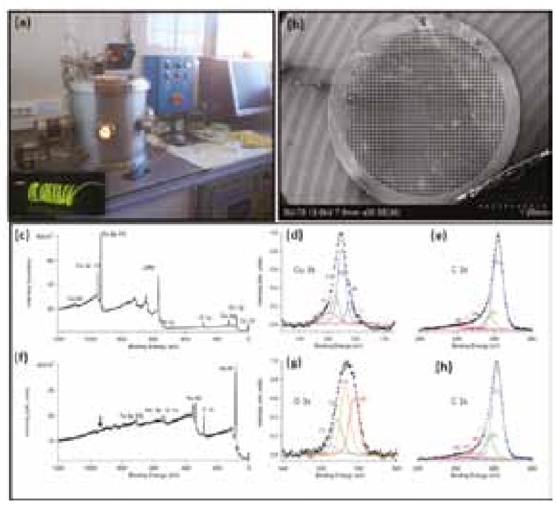

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FIGURE 1

(a) Homemade Hot-filament Thermal CVD set up for the large area graphene growth.
(b) SEM image of Graphene transfer to Cu grid. (c-e) XPS study of as grown graphene on Cu substrate and (f-h) graphene transfer to Au substrate.

FIGURE 2

(a-c) High-resolution TEM image of transferred graphene sheets, and corresponding FFT pattern confirms the bilayer nature of transferred graphene sheet. (d) Shows a combined current and topography image by C-AFM wherein the conducting domain is represented by green color and non-conducting areas are seen as red spots. We further confirmed our mechanistic hypothesis by depositing graphene on Ni and SiO_2/Si substrates. HFTCVD can be further extended to dope graphene with various heteroatoms (H, N, and B, etc.,), combine with functional materials (diamond, carbon nanotubes etc.,) and can be extended to all other materials (Si, SiO_2, SiC etc.,) and processes (initiator polymerization, TFT processing) possible by HFCVD and thermal CVD.
In the continuation of the present work group is extensively involved in further development of Graphene research in the field of Electronics, Biosensor and Energy applications.