The hidden influence of the flux of gas on the growth of graphene layers by low pressure chemical vapor deposition

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Abstract

The extraordinary properties of graphene make it one of the most interesting materials for future applications in electronics, optics and structural materials. Among the various synthetic methods, chemical vapor deposition (CVD) is the one that opens the possibility to obtain large areas of monolayer graphene without defects. To achieve this, it is important to find the appropriate conditions for each experimental system. In particular, for our CVD reactor working at low pressure, important factors appear to be the pretreatment of the copper substrate, considering both its cleaning and its annealing before the growing process and the flows of methane and hydrogen. Copper substrate is usually exposed to methane, hydrogen and argon gases and, the growth is taking place at 1000°C. In this work, we have focused on the study of the methane and the hydrogen flows to control the production of mono and bilayer graphene. In particular, we observe that different hydrogen flows can result in the growth of smooth hexagonal graphene domains or random formed domains. This is a result of the etching effect that hydrogen performs on the growing graphene. It is important, therefore, to study the moderated presence of hydrogen, which allows to form flat hexagonal domains.
Structural characterization was performed by Raman spectroscopy and morphological by scanning electron transmission microscope. The characteristic 2D Raman peak showed a ratio 2D/G > 1 owing to the formation of mono or bilayer graphene. The SEM exploration provided characteristic shape and size of the graphene domains as a result of the etching process that the different H_2 fluxes produce. Further investigation needs to be done in order to achieve the synthesis of graphene domains large enough to be use full for applications.

References

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Figures

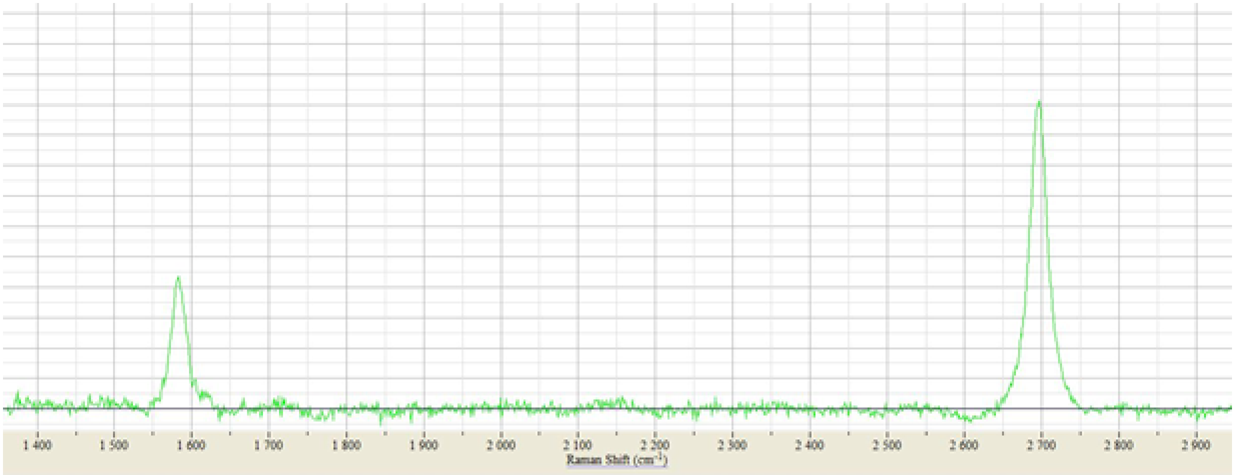

Figure1RAMAN spectrum of a graphene layer

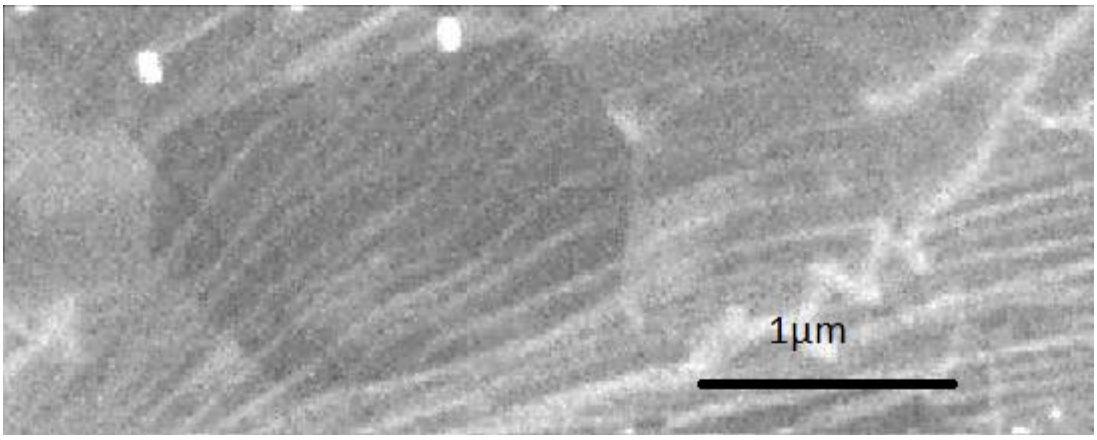

Figure 2. Typical hexagonal graphene domain of sample (14G14), grown under 60 Pa of methane, H_2 and Ar mixture during 10 min at 1000ºC.

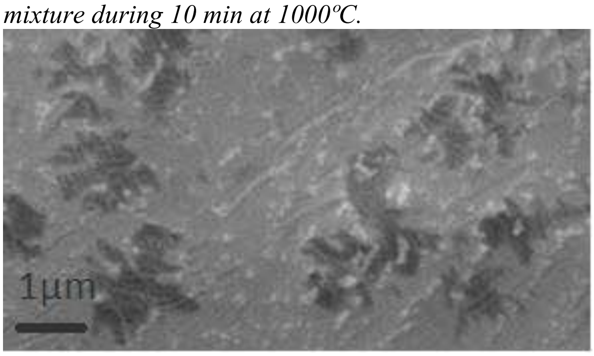

Figure 3 Randomly etched formed graphene domains, as a result of the H_2 rich gas mixture and similar conditions shown in Figure 2. (sample 14G1101)

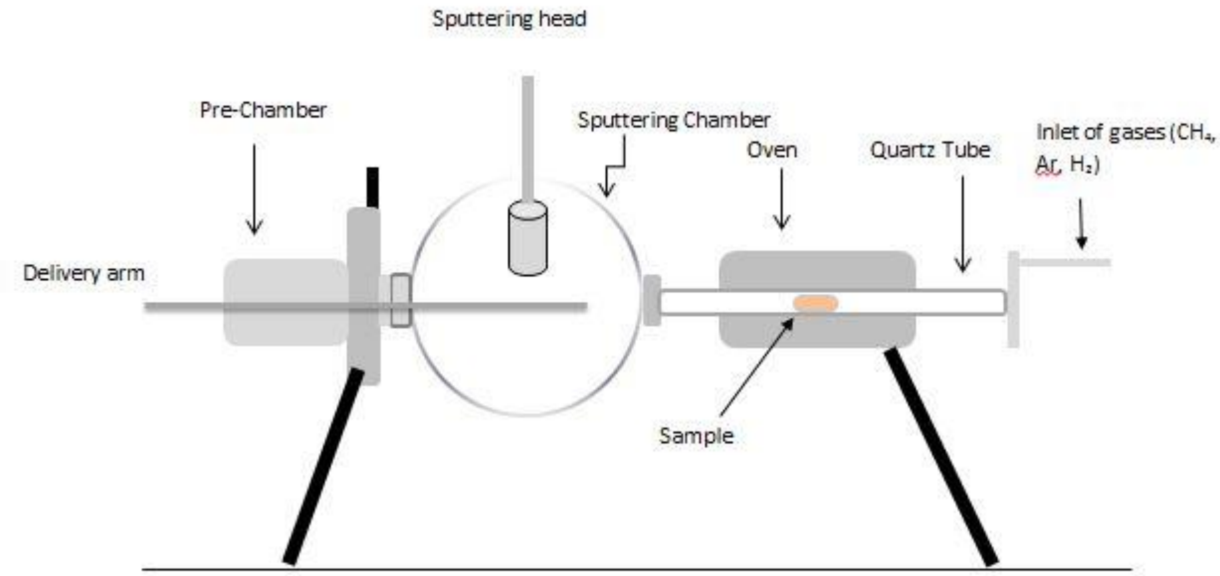

Figure 4. Reactor scheme

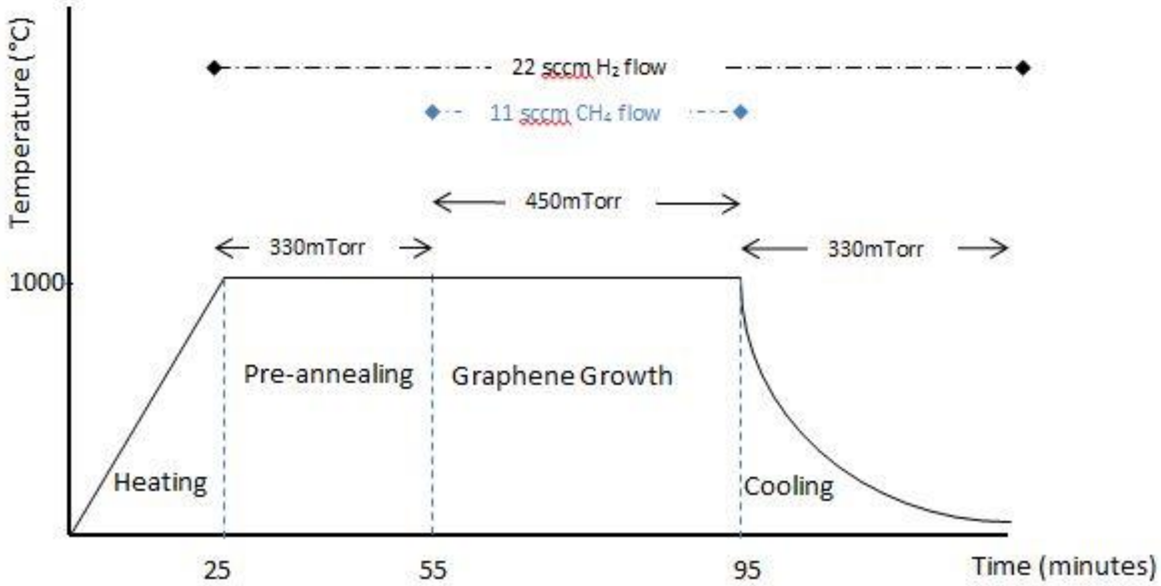

Figure 5 Plot of the oven temperature vs. time during the growth of graphene. The pressure and gas flow events during synthesis have been indicated in the graph.