Conditions for Production of Defect Free Graphene on Catalyst Melt Surface in CVD – Synthesis

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As of now the research for the graphene monolayer production ways via CVD- methods on a crystalline substrate has not been a success. In this regard, some interest starts to concentrate on graphene growth process on molten substrate which does not impose its intrinsic crystalline matrix to graphene. On the contrary, the metal atoms in a surface layer of the melt place themselves fit to a crystalline lattice, organized by the carbon atoms.

The monolayer graphene growth was practically realized on the copper melt surface [1]. Methane CH4 was used in this process as a gaseous carbon carrier.

We considered the nucleation of the ensemble of the islands on the copper catalyst surface, whose surface thin layer is supersaturated with carbon.

The nucleation of the islands, their rapid growth and consequent supersaturation decrease were considered in self-consistent way within the Lifshitz-Slëzov’ homogeneous nucleation theory (explosive nucleation). At the same time, such calculation reveals the conditions under which hexagonal shape of the islands is of preserved.

Subsequent calculation of the fast nucleation stage, when new islands are not formed whereas the old ones absorb carbon atoms in diffusion mode, allows the parameters region to be determined, within which both the dispersion and the shape deterioration of the islands are minimal.

Plunged into this parameter region in the conditions of the absence of stiff crystal matrix the hexagonal islands can agglomerate to form defect free graphene. The calculation show that practically found combination of the parameters can only be implemented for melted copper. Their approximate correspondence with the experimental date enables this method to be improved.

[1].D.Geng, B.Wu, Y.Guo, L.Huang, Y.Xue, J.Chen, G.Yu, L.Jiang, W.Hu, Y.Liu. Uniform hexagonal graphene flakes and films grown on liquid copper surface. www.pnas.org/cgi/doi/10.1073/pnas.1200339109