Grain boundary-free large-area monocrystalline graphene growth

Van Luan Nguyen[1,2], Dinh Loc Duong[1†,] Sung Tae Kim[1,2], David Perello[1], Young Jin Lim[3], Qing Hong Yuan4, Feng Ding[5,6], Seung Mi Lee[7], Sang Hoon Chae[1,2], Quoc An Vu[1,2], Seung Hee Lee[3], Young Hee Lee[1,2]*

[1]IBS Center for Integrated Nanostructure Physics, Institute for Basic Science, Sungkyunkwan University, Suwon 440-746. Korea.
[2]Department of Energy Science, Department of Physics, Sungkyunkwan University, Suwon 440-746. Korea.
[3]Department of BIN Fusion Technology and Department of Polymer-Nano Science and Technology, Chonbuk National University, Jeonju, Jeonbuk, 561-756, Korea.
[4]Department of Physics, East China Normal University No. 500, Dongchuan Road, Shanghai, China.
[5]Institute of Textiles and Clothing, Hong Kong Polytechnic University, Kowloon, Hong Kong S. A. R, China.
[6]Beijing Computational Science Research Center, Beijing 100084, Peoples Republic of China.
[7]Center for Nanomaterials Characterization, Korea Research Institute of Standards and Science, Daejeon 305-340, Korea.
Contact@E-mail: leeyoung@skku.edu

Formation of graphene grain boundaries (GGBs), which govern transport properties and related device performance, inevitably occurs via coalescence of graphene domains during chemical vapour deposition[1-5]. Here we report a concept of stitching hexagonal graphene domains without forming GGBs, leading to a centimeter-scale monocrystalline graphene. This concept was realized by maintaining the hexagonal shape of graphene domains and aligning them to lead to commensurate stitching on a polished Cu(111) foil. The existence of commensurate stitching without forming GGBs was verified by correlating confocal Raman mapping of overlapped graphene bilayer to polarizing optical microscopy of graphene coated by nematic liquid crystals layer, UV treated-graphene and transport measurements at the stitched region. No appreciable conductivity change across the stitched region was observed. Our strategy will be a shortcut to grow high-quality large-area graphene and provide intuition to grow other types of 2D materials of BN and transition metal dichalcogenides.

References

[1] Duong, D. L. et al. Probing graphene grain boundaries with optical microscopy. Nature 490, 235-239 (2012).

[2] Yu, Q. et al. Control and characterization of individual grains and grain boundaries in graphene grown by chemical vapour deposition. Nature Mater. 10, 443-449 (2011).

[3] Tsen, A. W. et al. Tailoring electrical transport across grain boundaries in polycrystalline graphene. Science. 336, 1143-1146 (2011).

[4] Yazyev, O. V. and Louie, S. G. Electronic transport in polycrystalline graphene. Nature Mater. 9, 806-809 (2010).

[5] Tuan, D. V., Kotakoski, J., Louvet, T., Ortmann, F., Meyer, J. C., and Roche, S. Scaling. Scaling Properties of Charge Transport in Polycrystalline Graphene. Nano Lett. 13, 1730-1735 (2013).