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Patterned growth of graphene by using seed

Abstract

Graphene with high flexibility, optical transparency and carrier mobility is attracting interest in the fields of next generation nanoelectronic devices. Especially, in the area of field effect transistors, many researchers have performed to use graphene as a channel material because of its thinnest layer and high carrier mobility. There are many ways to get graphene such as mechanical exfoliation from graphite by using scotch tape[1] or AFM(Atomic force microscope)[2], chemical exfoliation from graphited oxide by using Hummer's method[3] and epitaxial growth[4]. However, mechanical exfoliation is hard to make large scale of graphene so this method is not suitable for industrial application. Also chemical exfoliation is suitable to make large scale of graphene but it needs to be oxidized and reduced. Although chemical exfoliated graphene is reduced some oxygen still remain so it is called graphene oxide(GO) not graphene. Therefore, since graphene is not reduced entirely, graphene's quality is not good. To overcome these problem, chemical vapor deposition(CVD) method is suggested[5]. CVD method could make large scale of graphene and the price of synthesis is financial compared other method. Therefore, or CVD method is attracted to synthesis graphene recently. However, there are still many huddles to use CVD method such as defect during transfer process, transfer material residues, controlling nucleation density and number of layer. Especially there are many challenges to decrease nucleation density. Because many nucleation makes poly-crystalline graphene, graphene's quality is bad. To decrease the nucleation density many methods have been suggested. The best well known method of those is oxidizing copper before the growth step[6]. Also making pattern by using chromium as a seed of graphene has been done[7].

In this study, we synthesized grapheme film using seeds such as chromium and nickel. The seeds help to control the nucleation sites and it is related with decreasing nucleation density and quality of graphene. the surface of copper[8] was polished electro-chemically to smooth and decrease the nucleation density[9].

We made seed pattern in shape of hexagon which has length of 5μm and the distance of seeds was 200μm, 500μm and 1mm. we investigated the roll of each different seed and character. We got high quality graphene film which is consisted of well-aligned single-crystalline graphene hexagons.

References

[1] K. S. Novoselove, et al., Science, 306 (2004) 666.
[2] Y. Zhang, et al., Appl. Phys. Lett., 86 (2005) 073104
[3] W. S. Hummers, et al., J. Am. Chem. Soc., 80 (1958) 1339.
[4] L. Gao, et al., Nano Letters, 10 (2010) 3512-3516.
[5] K. S. kim, et al., Nature, 457 (2009) 706.
[6] D. Ding, et al., Appl. Surf. Science., 408 (2017) 142-149.
[7] M. Vaidotas, et al., 2D Mater., 4 (2017) 021004.
[8] M. Kim, et al., 2D Mater., 4 (2017) 035004
[9] B. Bekdüz, et al., Nanotechnology, 28 (2017) 185601

Figures

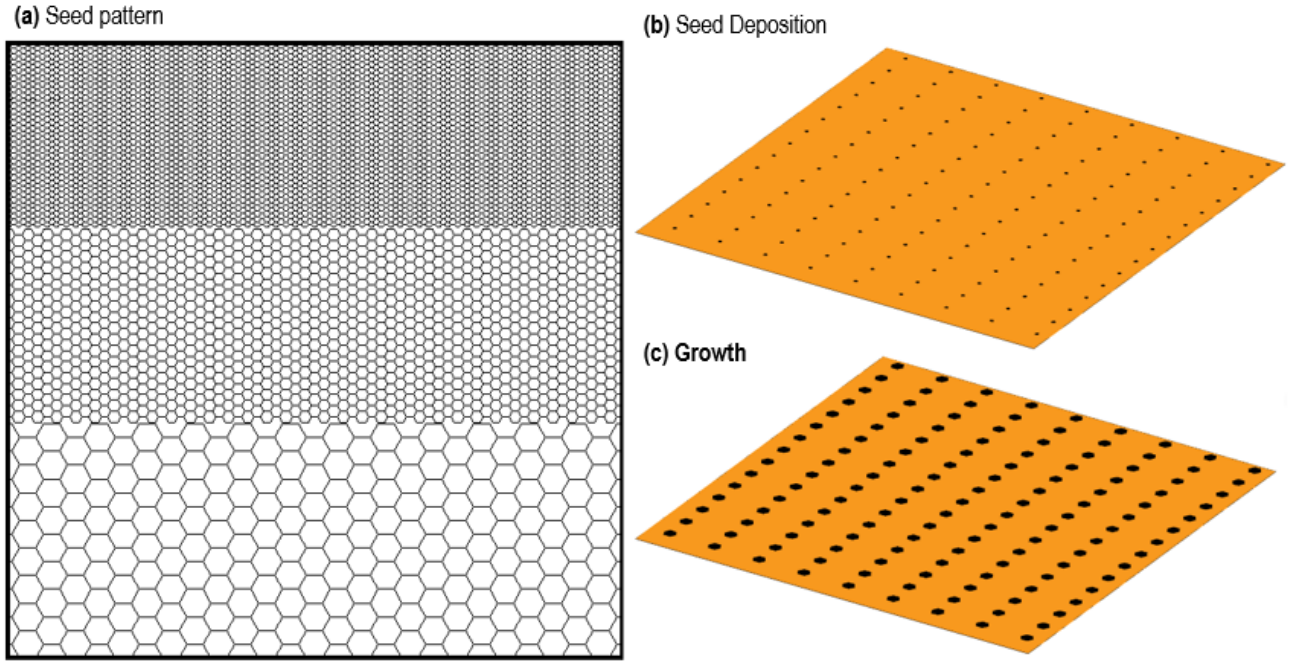

Figure. (a) Seed pattern of photomask. The distance between hexagonal seeds are 200μm, 500μm, 1000 μm. (b) Seeds are deposited on the copper surface. (c) Hexagonal graphene islands on copper.