NM-P003

Hexagonal Boron Nitride Monolayer Growth without Aminoborane Nanoparticles by Chemical Vapor Deposition

Jaehyu Han, Jong-Souk Yeo

School of Integrated Technology, College of Engineering, Yonsei University, Incheon, Korea

Recently hexagonal boron nitride (h-BN), III-V compound of boron and nitrogen with strong covalent sp^2 bond, is a 2 dimensional insulating material with a large direct band gap up to 6 eV. Its outstanding properties such as strong mechanical strength, high thermal conductivity, and chemical stability have been reported to be similar or superior to graphene. Because of these excellent properties, h-BN can potentially be used for variety of applications such as dielectric layer, deep UV optoelectronic device, and protective transparent substrate. Ultra flat and charge impurity-free surface of h-BN is also an ideal substrate to maintain electrical properties of 2 dimensional materials such as graphene. To synthesize a single or a few layered h-BN, chemical vapor deposition method (CVD) has been widely used by using an ammonia borane as a precursor. Ammonia borane decomposes into hydrogen (gas), monomeric aminoborane (solid), and borazine (gas) that is used for growing h-BN layer. However, very active monomeric aminoborane forms polymeric aminoborane nanoparticles that are white non-crystalline BN nanoparticles of 50~100 nm in diameter. The presence of these BN nanoparticles following the synthesis has been hampering the implementation of h-BN to various applications. Therefore, it is quite important to grow a clean and high quality h-BN layer free of BN particles without having to introduce complicated process steps. We have demonstrated a synthesis of a high quality h-BN monolayer free of BN nanoparticles in wafer-scale size of 7×7 cm^2 by using CVD method incorporating a simple filter system. The measured results have shown that the filter can effectively remove BN nanoparticles by restricting them from reaching to Cu substrate. Layer thickness of about 0.48 nm measured by AFM, a Raman shift of 1,371～1,372 cm^{-1} measured by micro Raman spectroscopy along with optical band gap of 6.06 eV estimated from UV-Vis Spectrophotometer confirm the formation of monolayer h-BN. Quantitative XPS analysis for the ratio of boron and nitrogen and CS-corrected HRTEM image of atomic resolution hexagonal lattices indicate a high quality stoichiometric h-BN. The method presented here provides a promising technique for the synthesis of high quality monolayer h-BN free of BN nanoparticles.

Acknowledgement

This research was supported by the MSIP (Ministry of Science, ICT and Future Planning), Korea, under the "IT Consilience Creative Program" (NIPA-2013-H0203-13-1002) supervised by the NIPA (National IT Industry Promotion Agency). This research was also partially supported by a grant from the Joint Program for Samsung Electronics-Yonsei University.

Keywords: hexagonal boron nitride, chemical vapor deposition