Confocal Laser Scanning Microscopy as a Real-time Quality-assessment Tool for Industrial Graphene Synthesis

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For the industrial quality control (QC) of the chemical vapor deposition (CVD) graphene, it is essential to develop a method to screen out unsatisfactory graphene films as efficiently as possible. However, previously proposed methods based on Raman spectroscopy or optical imaging after chemical etching are unable to provide non-invasive and fast analysis of large-area graphene films as grown on Cu foil substrates. Here we report that the reflection mode of confocal laser scanning microscopy (CLSM) provides a high-contrast image of graphene on Cu, enabling the real-time evaluation on the coverage and quality of graphene. The reflectance contrast, RC, was found to be dependent on the incident laser wavelength, of which the maximum was obtained at 405 nm. In addition, RC decreases with increasing defect density of graphene. The dependence of RC on the graphene's quality and laser wavelengths were explained by the tight-binding model calculation based on the Fresnel's interference formula. Thus, we believe that the reflection mode CLSM would be a very powerful quality-assessment tool for the mass production of CVD graphene films grown on Cu.

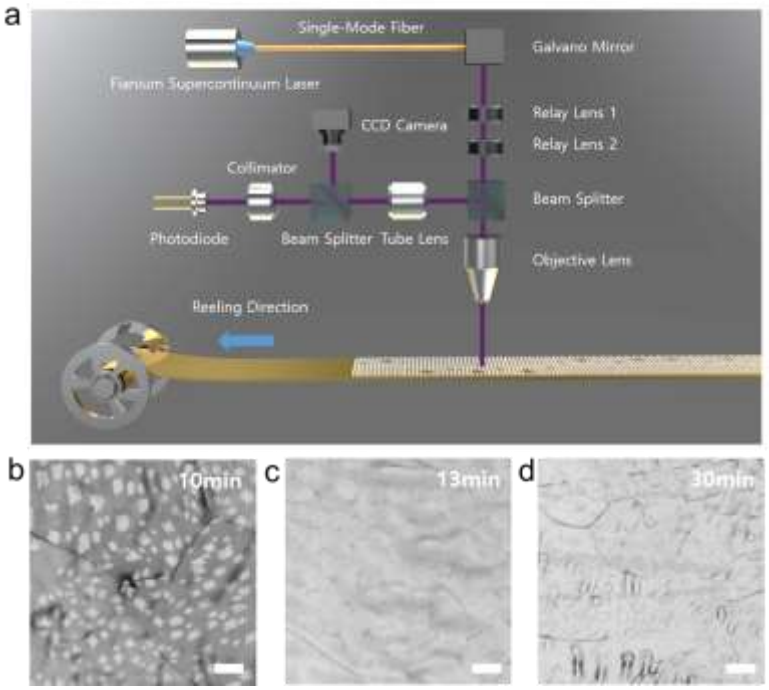

Figure 1: Concept of in-situ monitoring of the as-grown CVD graphene on Cu using CLSM. a) The concept of monitoring the as-grown CVD graphene on Cu foil during the continuous roll-to-roll synthetic process using the reflective mode CLSM. b)-d) The CLSM images of the CVD graphene with various coverage from sub-monolayer to fully covered on Cu foil controlled by growth time of 10, 13, and 30 min, respectively. High visibility of graphene on Cu in CLSM images of b)-d), in which the graphene domain is a bright region and Cu is a dark region, makes it possible to determine whether graphene growth is complete. Scale bar: 10μm.