STXM Study on Layered Nanomaterials: Graphene & TMD

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Graphene exhibits unique mechanical, optical, and electronic properties, making it one of the most promising materials in prominent electronic devices [1]. To do so, it is essential to develop a method to synthesize large-scale high-quality graphene samples [2]. However, the most common growth technique, chemical vapor deposition (CVD), suffers from quality issues, which can arise from the high-temperature growth process as well as during the transfer process. In addition, chemical doping/cleaning process using plasma or wet chemistry further adds defects [3-4]. Therefore, in order to refine CVD graphene synthesis, transfer and post-treatment methods, it is important to effectively obtain information regarding defects and surface states during the process.

Scanning transmission x-ray microscopy (STXM) is a promising experimental technique to study relevant physical and chemical information on graphene structure/defects by measuring the C 1s near-edge x-ray absorption fine structure (NEXAFS) which can give electronics/chemical states usually associated with different types of bonding and defects. In Fig. 1, we depict our preliminary data obtained for two different typical graphene samples (exfoliated a-few layer and CVD-grown/transferred monolayer graphene). The monolayer graphene was found to give enough signal-to-noise ratio for image and spectroscopic analysis. In the case of polymer-assisted transferred CVD graphene, we could observe some organic residues originating from the polymer coating and the non-flat non-uniform structural characteristics like wrinkle/folding which is not found in the exfoliated samples. The inherent chemical analysis based on the x-ray spectro-microscopic method can identify the chemical species of the organic contaminants on the sample and the corresponding surface states of the surface-modified/functionalized sample which is very important for utilizing the graphene to various electronic, photonic and bio-oriented energy/sensing applications. By using these experimental fingerprints, we can reduce the damage and surface contamination during the post process. Therefore, our microscopic understanding will give a hint to prepare large-area graphene materials with controllable post-treatment for practical device applications.

References:

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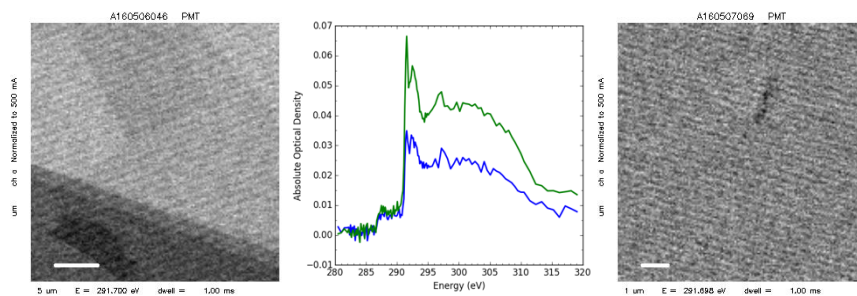
Figure 1. STXM data of exfoliated and CVD-grown monolayer graphene.
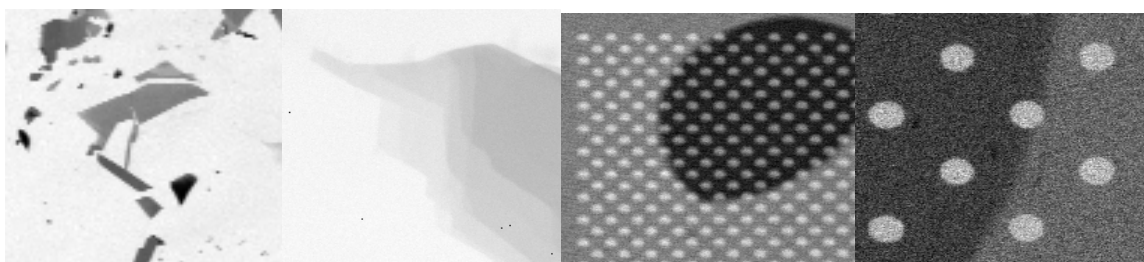
Figure 2. STXM data of exfoliated and MBE-grown TMD.