FOCUSED ELECTRON BEAM INDUCED PROCESSING VIA MULTI-MODE ENERGIZED MICRO/NANO-JETS TO ENABLE ADVANCES IN GRAPHENE NANOELECTRONICS

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ABSTRACT

Focused Electron Beam Induced Deposition (FEBID) is a chemical vapor deposition method that enables direct-write nanoscale fabrication with a variety of materials. Compared to a similar technique – focused ion beam deposition – FEBID can achieve much higher resolution, inflicts less surface damage, and involves more accessible tools. However, FEBID is not widely used due to its limited deposition rate, low material purity, and limitation on a type of precursor materials which can be delivered to a high vacuum environment of the FEBID chamber. We are developing a family of multi-mode energized micro/nano-jet techniques as a method of local precursor delivery, which may be used to resolve both issues, as well as to expand the range of useful precursors for applications in FEBIP.

Energized micro/nano-jets provide unique capabilities for localized delivery of precursor molecules to the substrate, thus establishing locally controlled deposition/etching site for focused electron-beam induced processing (FEBIP). Not only this allows one to perform FEBIP from precursor materials of different kinds, thus expanding significantly the range of usable precursor molecules, but also modifies the properties of the deposition substrate, which affords tuning of precursor and contaminant sticking coefficients and adsorption/desorption activation energies. The latter is especially critical for substrates, which are sensitive to doping, such as graphene, whose electronic properties are readily modified by adsorption of different molecules.

In this presentation, we will discuss the fundamentals of several new methods we have developed for formation of energized precursor micro/nano-jets upon emanation into a vacuum environment of the FEBIP chamber. The results of experimental characterization of the jet behavior upon impact on the substrate will be presented with implications to FEBID deposit growth rate, topology and resolution. Complimentary simulations will also be presented to relate the jet structure, molecular flux and impingement energy at the location of the nanoscale deposition to the experimentally observed trends. Implications of these new FEBIP modes to fabrication of graphene nanoelectronic devices will also be briefly discussed.

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