Synthesis, Characterization, Properties, and Applications of 2D materials: Graphene, h-BN and TMDs

R. Ghosh¹, A. Ismach¹, H. Chou¹, L. Colombo², R. S. Ruoff¹

¹Department of Mechanical Engineering and the Materials Science and Engineering Program, The University of Texas at Austin, Austin, Texas 78712
²Texas Instruments, 13121 TI Boulevard, Dallas, Texas 75243

Two-dimensional atomic layered materials are very interesting from scientific and application points of view. Their chemical and physical properties may significantly differ from the bulk, thus opening the possibility of tuning material properties solely by film thickness. In particular, graphene-based materials hold promise due to their exceptional electronic and thermal transport, mechanical properties, high surface area, and as functional atom thick layers, barriers, or membranes. In order for these exciting properties to be translated into useful applications, their synthesis must be predictable and yield high-quality products.

Here we will review low-pressure chemical vapor deposition (LPCVD) and outline the main challenges in achieving large-scale and high quality graphene.[1] Isotopic labeling by 13C vs 12C to study of the kinetics and growth mechanisms on copper surfaces[2] will be presented. Preliminary results with LPCVD include achieving millimeter-large single crystal graphene domains, making CVD on copper substrates perhaps the best candidate for creation of large-scale, high quality graphene films. Initial results for controlled growth of high quality h-BN using CVD will be discussed. [3] The process similarities with synthesis of graphene allow for, potentially, the direct synthesis of h-BN and graphene layers in the same system. Similarities/dissimilarities with the graphene system will be emphasized. Finally we will also review our recent work in the APCVD transition metal dichalcogenide growth and novel characterization techniques.

We appreciate support from the Army Research Office, the Office of Naval Research, the National Science Foundation, and the W. M. Keck Foundation, the SWAN-NRI, LEAST, the Department of Energy, and prior support from DARPA.

References: