IBS Center for Multidimensional Carbon Materials

Tuesday Colloquium

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Towards developing energy efficient systems Based on novel carbon materials

Tuesday, DEC 6
2 PM

Bldg. 101
Seminar room on the 1st floor

Minimizing friction and wear-related mechanical failures remains as one of the greatest challenges in today's moving mechanical systems leading to a search for new materials that can reduce friction and wear related energy losses and the understanding of fundamental mechanisms that control friction. In this context, our work on graphene has shown that this materials properties can be manipulated at the atomic level to achieve exceptionally high wear resistance, as well as well as achievement of superlubricity (or near zero friction) at macroscale through combined use of graphene and nanodiamonds on sliding surfaces [1]. This discovery presents a paradigm shift in understanding frictional behavior of graphene and other 2D materials and offers a direct pathway for designing energy efficient frictionless tribological systems. In the second part of my talk, I'll describe our recent work on direct growth of wafer-scale graphene on diamond. The fact that the one atom thick graphene membrane strongly affected by the substrate interactions puts limit on exploiting excellent intrinsic properties of graphene for various applications. Diamond offers multiple unique properties, such as high phonon energy, low trap density, and high thermal conductivity, which make it an ideal substrate for fabricating graphene devices on diamond [2]. We demonstrate a novel process to grow large area single and few layer graphene directly on the diamond thin film deposited on silicon wafer thus eliminating the need for graphene transfer [3]. This approach offers new opportunities for developing graphene based nanoelectronic devices directly on dielectric substrate (diamond/Si) and provides reliable, efficient and low cost alternative as compare to current methods.

References:
[1] Macroscale Superlubricity Enabled by Graphene Nanoscroll Formation; D. Berman, S. A. Deshmukh, S. Sankaranarayanan, A. Erdemir, and Anirudha. V. Sumant ; Science, 348, 1118-1122, (2015)
[2] Graphene-on-diamond devices with increased current-carrying capacity: Carbon sp2- on-sp3 planar technology ; Jie Yu, Guanxiong Liu, Anirudha V. Sumant, Vivek Goyal, Alexander A. Balandin ; Nano Letters, 12(3), 1603 (2012).
[3] Metal-induced rapid transformation of diamond into single and multilayer graphene on wafer-scale ; Diana Berman, Sanket Deshmukh, Badri Narayanan, Subramanian Sankaranarayanan, ; Z. Yan, Alexander Balandin, Alexander Zinovev, Daniel Rosenmann, and Anirudha V. Sumant; Nature Communications, 7:12099 doi: 10.1038/ncomms12099 (2016).

You are cordially invited to attend!