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2D Flatlands – Synthesis, Characterization and Applications

I will present our investigation of chemical vapor deposition (CVD)-growth, achieving localized, patterned, single crystalline or polycrystalline monolayers of TMDs, including MoS_2, WS_2, WSe_2 and $MoSe_2$, as well as their heterostructures. We study CVD-growth and perform extensive material characterization to illuminate the role of dissimilar 2D substrates in the prevention of interior defects in transition metal dichalcogenides (TMDs), thus uncovering the conditions for anti-oxidation. We further demonstrate the epitaxial growth of TMDs on hBN and graphene, as well as vertical/lateral heterostructures of TMDs, uniquely forming in-phase 2D heterostructures. This research provides a detailed observation of the oxidation and anti-oxidation behaviours of TMDs, which corroborate the role of underlying 2D layers in the prevention of interior defects in TMDs. If the technique could be developed to be highly reliable and high fidelity, it could have a large impact on the future research and commercialization of TMD-based devices. Furthermore, we develop flexible electrodes and energy storage toward wearable and multifunctional electronics. Here, we develop a facile fabrication technique utilizing vertically aligned carbon nanotubes (VACNTs), which enables high-throughput fabrication of flexible supercapacitors. We develop an innovative technique, which facilitates a stable charge/discharge under varied strains. Our structure shows a high flexibility and stability during stretching up to 20% and bending up to 180 degrees. These flexible supercapacitors are promising for various flexible electronics applications. Building on these previous results from 2D material growth and flexible electrodes, our next step is to combine 2D materials with flexible substrates toward next generation wearable detectors.

Biography

Eui-Hyeok Yang is a full professor of Mechanical Engineering Department at Stevens Institute of Technology, USA. He received his Ph.D. degree from Ajou University, Korea. After his postdoctoral training at University of Tokyo and at California Institute of Technology, he joined NASA's Jet Propulsion Laboratory (JPL) where he became a senior member of the engineering staff. In recognition of his excellence in advancing the use of MEMS-based actuators for NASA's space applications, he received the prestigious Lew Allen Award for excellence at JPL in 2003. His scholarly leadership has been recognized by peers. Examples of these efforts include appointment as an associate editor and/or editorial board member of several journals including Nature's Scientific Reports, and elected as the Division Chair of the ASME MEMS Division. Since joining Stevens in 2006, he has been responsible for obtaining competitive research funding from several federal agencies including NSF, AFOSR, US Army, NRO, NASA and DARPA (including 6 NSF and 3 AFOSR grants, and 5 NASA and 3 NRO contracts). Eui-Hyeok Yang holds over 12 patents (issued or pending). He is the director of the Micro Device Laboratory, a Stevens's multi-user microfabrication facility.

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