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1D and 2D Materials, Flexible Electrodes and Tunable Surfaces

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Presenting three of our primary research topics, as each relates to 1D/2D materials, substrates and surfaces. First, will focus on the investigation of chemical vapor deposition (CVD)-growth of transition metal dichalcogenides (TMDs) as well as their heterostructures and characterization to illuminate the role of dissimilar 2D substrates in the prevention of interior defects in TMDs. 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.

The second research area concerns our development and application of flexible electrodes and energy storage towards wearable and multifunctional electronics. Here, we develop a facile fabrication technique utilizing vertically aligned carbon nanotubes (VACNTs), which enables high-throughput fabrication of flexible electrodes. For example, our structure shows a high flexibility and stability during stretching up to 20% and bending up to 180 degrees, promising for various flexible electronics applications. Lastly, we investigate and utilize smart polymer functional surfaces using dodecylbenzenesulfonate-doped polypyrrole (PPy (DBS)); we demonstrate a novel in situ control of droplet pinning on the polymer surface, enabling the control of droplet adhesion from strongly pinned to extremely slippery (and vice versa). The pinning of organic droplets on the surfaces is dramatically controlled in situ, presenting great potential for manipulation and control of liquid droplets for various applications including oil separation, water treatment and anti-bacterial surfaces. We believe that our work represents a major advance in materials science and engineering, especially pertaining to those topics that involve functional and tunable surfaces.

Keywords: Transition Metal Dichalcogenides, 2D Materials, Flexible Electrodes, Oil/Water Separation

Biography:

Dr. E. H. Yang is a full professor of Mechanical Engineering Department at Stevens Institute of Technology. He worked as a Senior Member of the Engineering Staff at NASA's Jet Propulsion Laboratory (JPL). 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. He joined Stevens Institute of Technology in the Department of Mechanical Engineering in 2006. Currently, his group's research covers the growth and nanofabrication of graphene, carbon nanotubes and 2D materials, as well as the implementation of tunable wetting and surface interaction. Dr. Yang's service to the professional community includes formal appointments such as Editorial Board Member of Nature's Scientific Reports and Elsevier NANOSO and Associate Editor of IEEE Sensors and ASME JEECS. Dr. Yang has published hundreds of papers and provided keynotes, presentations and seminars at various academic and industrial events.