Controlling Functionality in 2D materials: From ferromagnetic and anticorrosive to optoelectronic and bio-applications

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A long-standing puzzle in the field of two-dimensional (2D) materials is the effect and understanding of different types of defects in their electronic, magnetic, catalytic, wear and optical properties. In this talk an overview of different defects in transition metal dichalcogenides (TMDs) and hBN monolayers will be presented. We will define the dimensionalities and different atomic structures of defects and discuss how these defects could be imaged and characterized with novel optical-driven techniques. We will emphasize the importance of vacancies, dopants and edges in TMDs and hBN, and how some of them can reduce metal salts into single atoms and metal clusters. In particular, we will show how dopants such as V and Fe can induce ferromagnetism in 2D TMDs. We will also describe the catalytic effects of edges, vacancies and local strain observed in hBN and MoxW(1-x)S2 monolayers by correlating the hydrogen evolution reaction (HER) with aberration corrected scanning transmission electron microscopy (AC-HRSTEM). These 2D materials can effectively be electrodeposited on metallic substrates to form thin films of different thicknesses, porosities and anticorrosive properties. We will also show that these defective materials exhibit novel phenomena when interacting with cells, DNA and other biomolecules. Finally, we will describe how to intercalate hBN with metals. These systems can then be exfoliated into monolayers. The properties of these intercalated systems also are unexpected and their properties will be discussed.

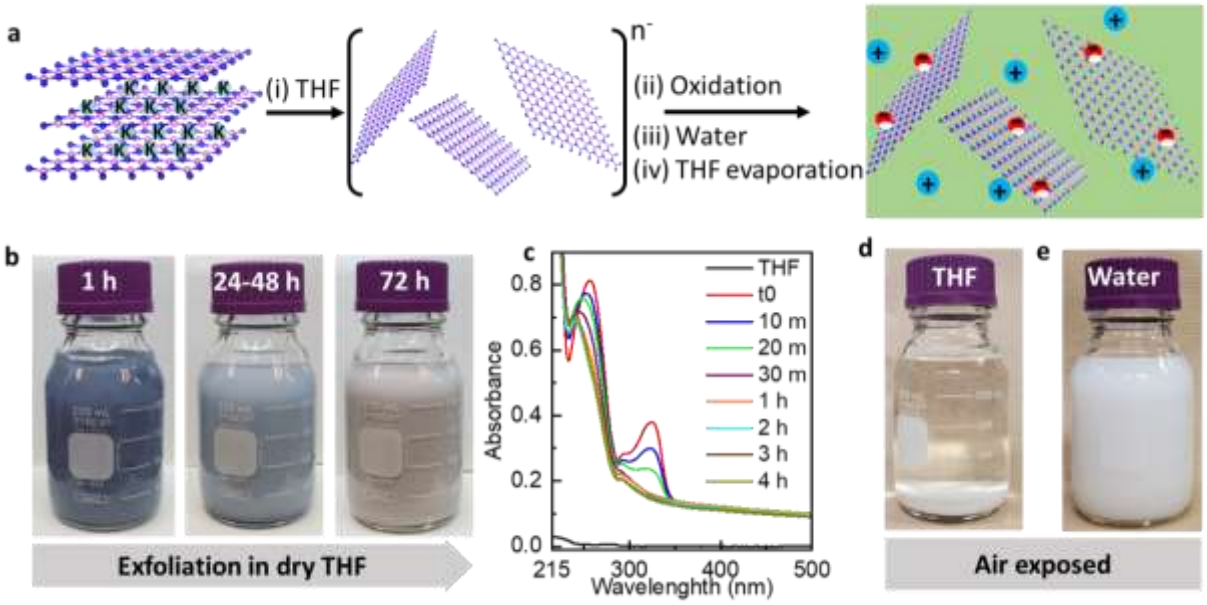

Figure 1: Exfoliation and dispersion of hBN nanosheets.