Why 2D (and why not)? A perspective on the promising (and not-so-promising) applications of 2D materials

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Abstract
Two-dimensional (2D) materials are a broad family of layered crystals characterized by strong intra-layer bonds, but with weak inter-layer coupling dominated by van der Waals forces. 2D materials have generated a great deal of excitement in the scientific community, and have started to be developed for many different applications ranging from scaled CMOS to biosensors. However, it remains unclear for which applications these materials can truly provide a benefit compared the state-of-the-art, or even other emerging material systems. In this presentation, I will describe my group's effort to identify and understand the unique properties of 2D materials and find ways that they can be exploited to create new functionality that is not possible using other material systems.

I will first consider graphene and its potential for realizing universal sensor platforms [1-3], optical modulators and detectors [4,5], and spintronic devices [6]. Next, I will discuss 2D semiconductors, including MoS_2 and WS_2, and their potential for dynamic memories [7] (Figs. 1(a)-1(b)) and ultimate-scaled logic [8]. These investigations have revealed some surprising new opportunities, such as dielectrophoretic sensors [9] and perfect absorbers [10], while at the same time identifying fundamental limitations of many of these materials [11] (Fig. 1(c)-(d)). My hope is that this talk will provide a fresh perspective into how to approach research into device applications of novel materials.

References

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Figures

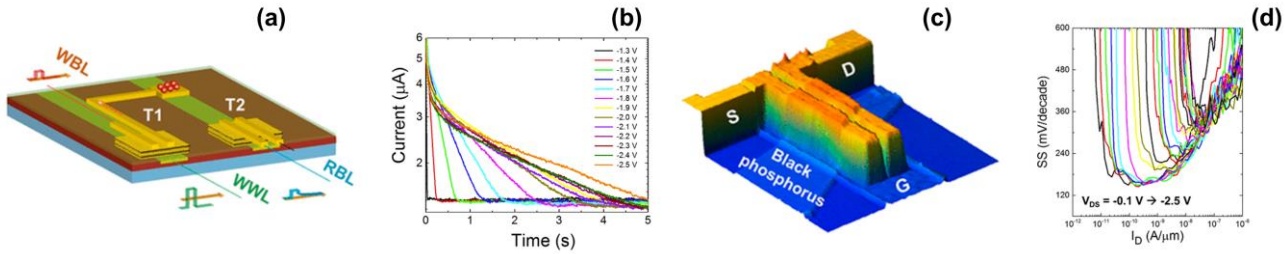

Figure 1: (a)-(b) Example showing a promising application of 2D MoS_2 for ultra-low-leakage DRAMs [7]. (c)-(d) Example showing fundamental limitations on the subthreshold slope of black phosphorus MOSFETs with Schottky contacts [11].