Field Effect Transistor with Monolayer Materials

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**OBJECTIVE**

This study intends to measure the operational parameters of a Field Effect Transistor built with single crystal monolayers coupled with h-BN, h-Hexane, and MoS2 to explore the interesting physics at this scale (figure 1).

**BACKGROUND**

Electronic devices are consistently growing smaller in size and pushing the fundamental limits of classical electronic properties. Using monolayer materials in conventional electronic devices such as transistors, necessitates a focus on surface science and quantum-scale functionality.

Monolayers can have unique properties when paired with other hexagonal structures. Graphene, overlaid with h-BN creates a super lattice, since their lattices are not perfectly matched. A repeating pattern with a larger characteristic lattice parameter occurs across the bilayer surface called a Moire pattern. The lattice parameter depends strongly on the angle at which the two monolayers are oriented. In addition, it changes the physical scale of the surface potential and topology.

**METHODS**

- **Mechanical Exfoliation:**
  The use of adhesive materials to mechanically remove single layers from a bulk substrate.

- **Van Der Waals Transfer:**
  Using temperature to control the van der Waals forces between two materials allows us to select the deposition layer.

The transfer of individual layers of the sample was performed using mechanical exfoliation and van der Waals methods (below).

**RESULTS**

The direction of our research has moved away from MoS2 FET studies. The FET characteristics of an MoS2 monolayer were already performed by a competing university and their results are shown in the 1-V plot below.

**CONCLUSIONS**

The use of MoS2 monolayers in an FET was verified. Now investigation of more refined structures is necessary to explore the effects of an h-BN/h-Hexane super lattice on FET operation. A device with several layers of h-BN will be fabricated with a single h-Hexane layer as the gate. The physical topology of the h-Hexane gate will be periodic and alter the field geometry within the MoS2 layer that creates the conducting channel within the semiconductor.