

**Stony Brook University  
The Graduate School**

Doctoral Defense Announcement

**Abstract**

Control of Graphene  
Through Ferroelectric  
Switching

By

**Mohammed Humed Yusuf**

Ferroelectric thin films possess high degrees of functionality with exploitable electrical, mechanical and optical properties. A key step towards realization of a new generation of multifunctional devices, in which a ferroelectric material is used to control other electronic materials, is to understand and obtain ideal interfaces between the two components. This was achieved in this thesis in graphene-ferroelectric superlattice field effect devices. The ferroelectric superlattice used was  $\text{PbTiO}_3/\text{SrTiO}_3$  (PTO/STO). In these systems, the Curie temperature of the superlattices is tunable by varying the PTO volume fraction. Extrinsic charge traps can be largely removed from the interface by making use of this functionality. As a result, a systematic study of the “intrinsic” ferroelectric substrate-associated charge traps on the graphene channel can be performed. By tuning of the superlattice growth parameters, the device behavior could be reproducibly modified between ferroelectric hysteresis, charge-trapping associated anti-hysteresis, and “cross-over” from anti-hysteresis to hysteresis over a wide temperature range from 300K down to 4K. These results established a deeper understanding of the graphene-ferroelectric interface.

Using the Graphene Ferroelectric Field Effect Transistors (GFeFETs) that were developed, re-writable nanoscale circuitry was created on the graphene channel in a deterministic way. This was accomplished by pressing with an Atomic Force Microscope (AFM) tip, which inducing a local strain gradient on the ferroelectric superlattice, switching the polarization under the tip and doping the graphene locally.

**Date:** 12<sup>th</sup> May 2016

**Time:** 10 am

**Place:** Physics Building, B-131

**Program:** Physics

**Dissertation Advisor:** Dr. Matthew Dawber,  
Dr. Xu Du