

## Attachment 1 – Research Topic Template

1. **Research Title:** Synthesis of 2-Dimensional Semiconductor Heterostructures
2. **Individual Sponsor:**  
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3. **Academic Area/Field and Education Level:** Materials Science and Engineering/  
 Nanoelectronic Materials/ Biosensing; Ph.D. level
4. **Objectives:** Develop scalable physical vapor deposition methods for 2-dimensional (2D) semiconductor-based material architectures and devices with tunable electronic properties for ultra-compact high-performance electronics and sensors.
5. **Description:** Development of large area and reduced temperature growth methods for two dimensional (2D) semiconducting materials and their heterostructures with other 2D electronic materials is needed for applications in flexible electronics, energy harvesting systems, and chemical/biological sensors. Single molecular layers of transition metal dichalcogenide (TMD) compounds (e.g., MoS<sub>2</sub>, WS<sub>2</sub>, MoSe<sub>2</sub>, etc.) provide a direct band gap, optical transparency, strong photoluminescence, electrical resistance sensitivity to ambient chemical agents, and accommodation of >10% mechanical strain without fracture. These characteristics make two dimensional (2D) TMDs appealing materials for diverse opto-electronic device applications. However the state of the art in TMD single and multi-layered heterostructure synthesis with controlled materials properties is far from that required for predicted applications. Currently mechanical exfoliation and high temperature chemical-vapor deposition are being used, which hinder the TMD synthesis scalability. Reduced temperature and scalable physical vapor deposition techniques for 2D semiconducting heterostructures are needed to realize these remarkable materials in applications of interest to the Air Force and DoD.
6. **Research Classification/Restrictions:** Not classified. Not restricted.
7. **Eligible Research Institutions:** Indicate to what organizations this topic should be provided.
  - DAGSI (Wright State University, AFIT, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati)  
**PA Approval #: 88ABW-2013-3021**
  - AFIT (only)
  - USAFA (only)  
 If you are submitting a topic for the USAFA, please indicate if you are also interested in sponsoring a USAF Cadet in summer of 2013 (**Avg Cost for USAF Cadet for 33 days was \$5000**)  
 Yes    No