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Nanoelectronics Team Efforts in 2D Materials and Electronics

U.S. ARMY RDECOM

ARL open campus

S&T Campaign: Materials Research
Nano & 2D Electronics

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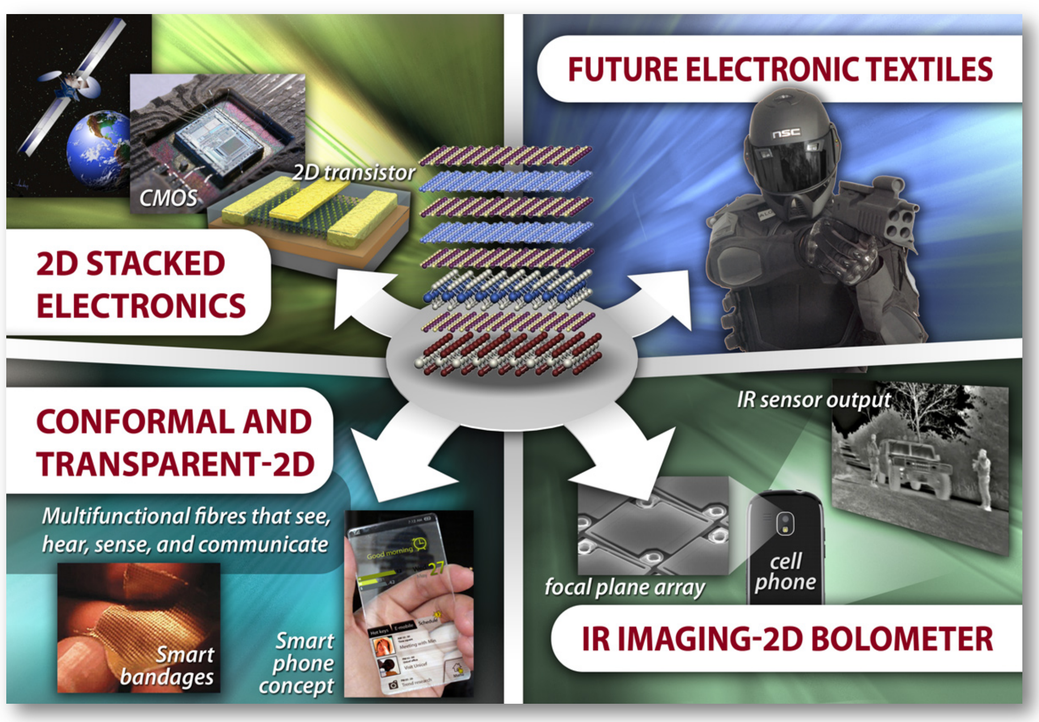
Research Objective

- To explore the properties and determine the advantages of 2D stacked materials and their interfaces for electronic applications.
- Paradigm Shifts: Flexible and Low Power Electronics

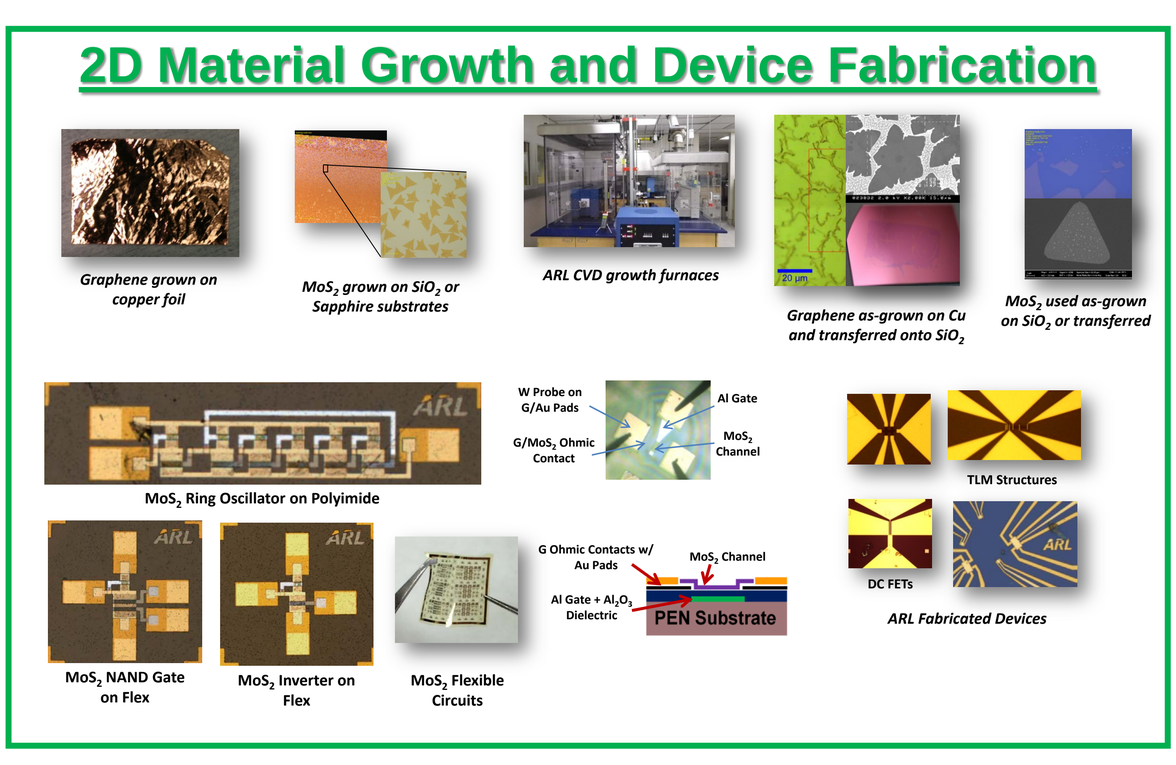


Efforts in 2D materials at ARL are focused in the following key areas: low power 2D electronic circuits, transparent electronics, flexible/conformal electronics, and low-cost, IR imaging.

Challenges

- ARL is exploring a number of major issues in 2D material development for electronic applications, including:
  - Investigating 2D material synthesis over large areas
  - Developing processes and fabrication integration for 2D material-based electronics
  - Understanding the interfacial and strain effects on electronic properties for 2D materials

2D Material Growth and Device Fabrication

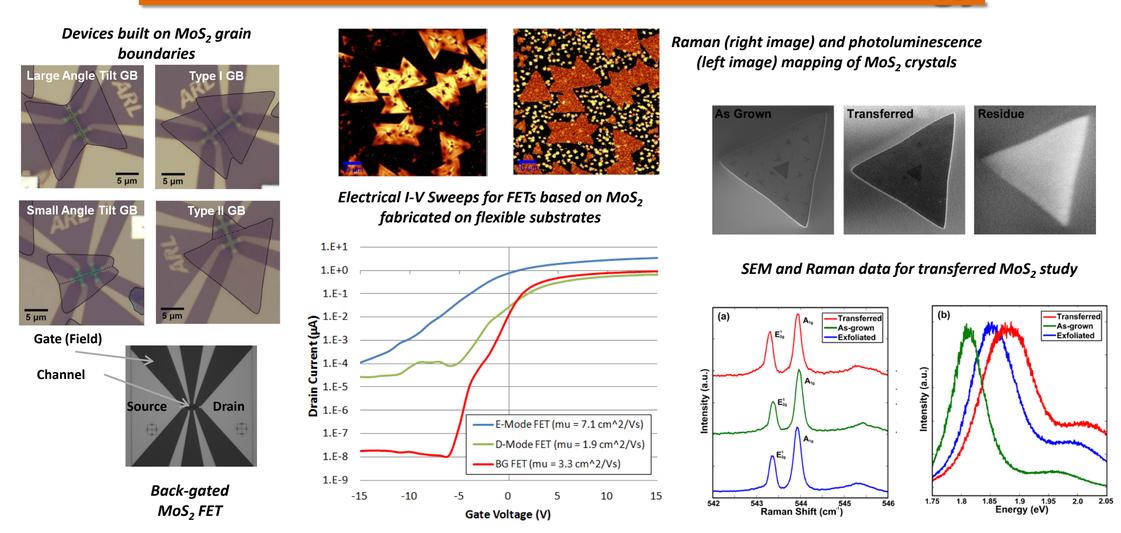


ARL Facilities and Capabilities Available to Support Collaborative Research

- Metrology tools including SEM, AFM, and Raman systems
- Electrical test beds including Hall and DC/RF probe stations
- 2D material growth systems for graphene and TMDs
- SEMASC 15,000 ft^2 cleanroom fabrication facility
- Expertise in 2D material growth, device fab & testing
- Recent Technical Publications from FY2014:

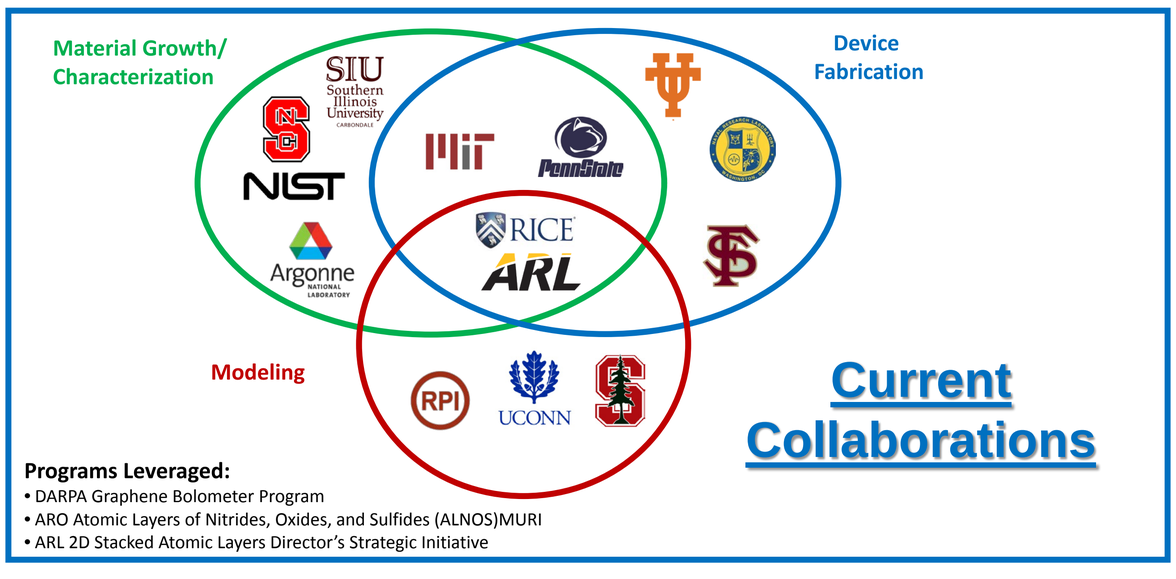
• M. Amani, M. Dubey, et al.; "Growth-substrate induced performance degradation in chemically synthesized monolayer MoS_2 field effect transistors." Applied Physics Letters, Vol. 104, 203506, May-2014.
• S. Najmaei, M. Dubey, et al., "Electrical Transport Properties of Polycrystalline Monolayer Molybdenum Disulfide"; ACS Nano, Vol. 8, No. 8, pp. 7930-7937, Jul-2014.

2D Materials Studies and Metrology



Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Modeling capabilities of 2D materials, their interfaces, and the electrical transport through them – ARL would like to partner with groups to perform experimental validation
- Expanded material characterization including TEM, STEM, STM, and in-situ measurements on strained 2D materials
- Novel 2D material growth for uniform, large area films
- Novel fabrication techniques for producing 2D electronics



Programs Leveraged:
- DARPA Graphene Bolometer Program
- ARO Atomic Layers of Nitrides, Oxides, and Sulfides (ALNOS)MURI
- ARL 2D Stacked Atomic Layers Director's Strategic Initiative

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