Photodetector Performance of Iron – doped MoS_2 - Based Field Effect Transistor Devices

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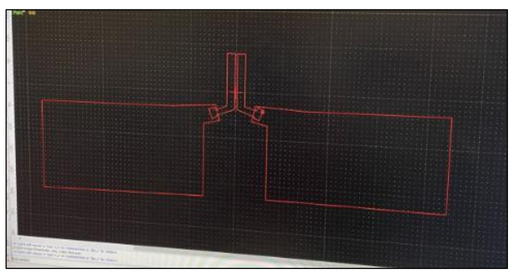
Introduction

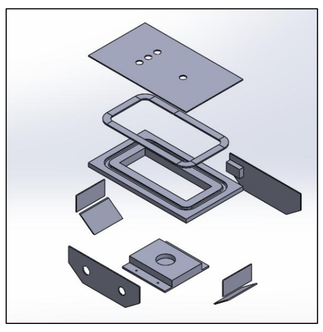
Burning fossil fuels release carcinogens such as nitrogen dioxide and sulfur dioxide. The US EPA has limited exposure of these gases to 53 ppb and 75 ppb, respectively. Due to this, a gas sensor that can detect in ppb levels is necessary to ensure the air we breathe is safe. Molybdenum disulfide is a two-dimensional transition metal dichalcogenide (TMD). Monolayer, single crystal Fe/MoS_2 form direct bandgap semiconductors that have applications in FET devices that can be used as ppb gas sensors.

Methodology

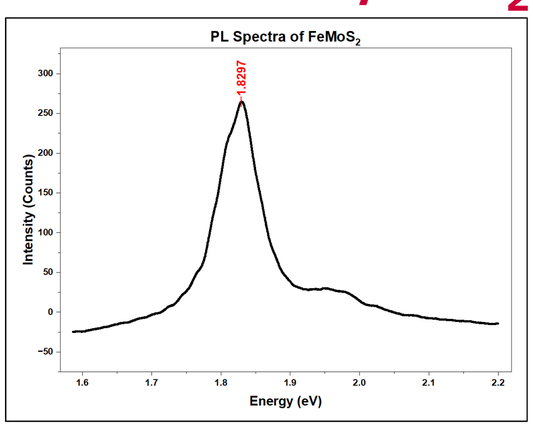
Procedures:

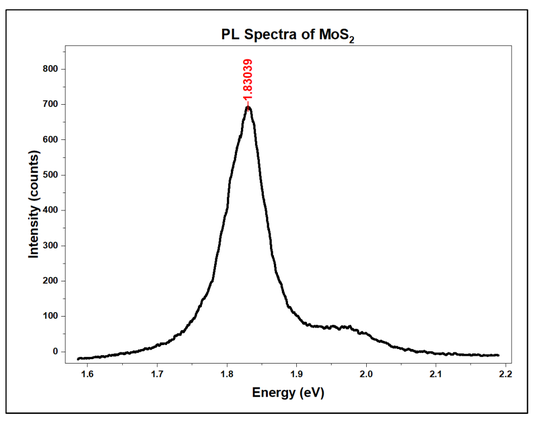
- Contact Chemical Vapor Deposition Growth Process: Used to grow Fe MoS_2 and MoS_2.
- Electron Beam Lithography Metal Deposition: Electrode pattern is etched onto PMMA coated NOVA silicon chips and gold is deposited to create the gold electrodes.
- PMMA Wet Transfer Process: Used to fabricate FET devices by joining crystals and gold electrodes.
- IV Measurements: Used to characterize fabricated Fe/ MoS_2 FET devices.
- Gas Sensing Chamber Design: Used to perform gas sensing tests on fabricated Fe/ MoS_2 FET devices.

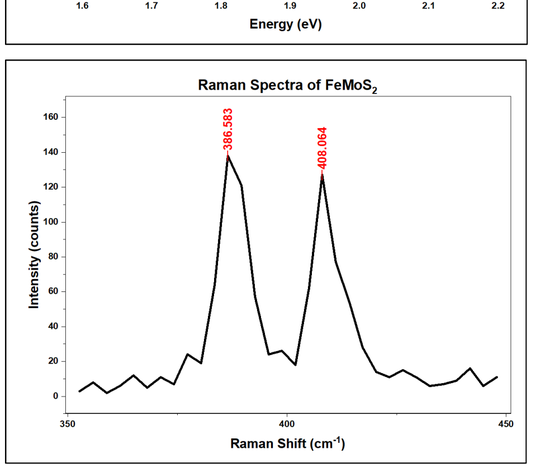


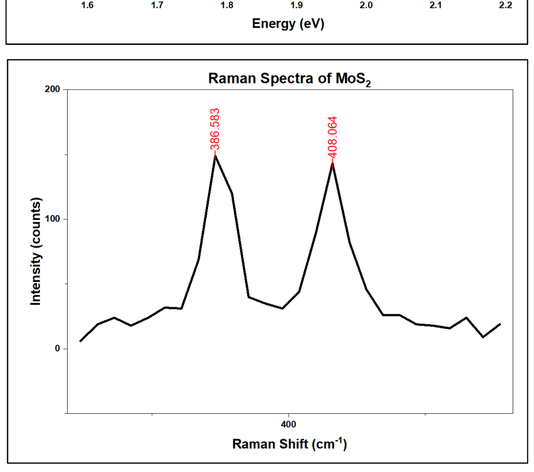


Results – Fe/MoS_2 Characterization

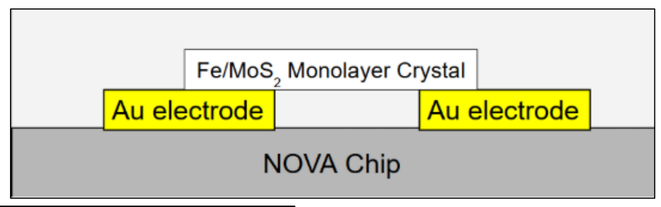


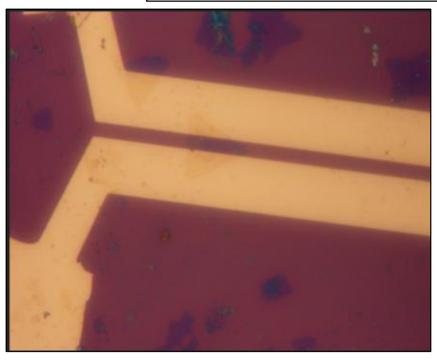


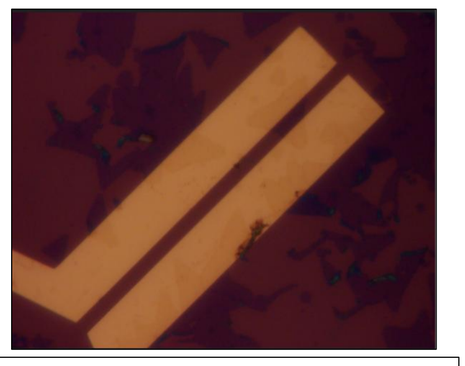


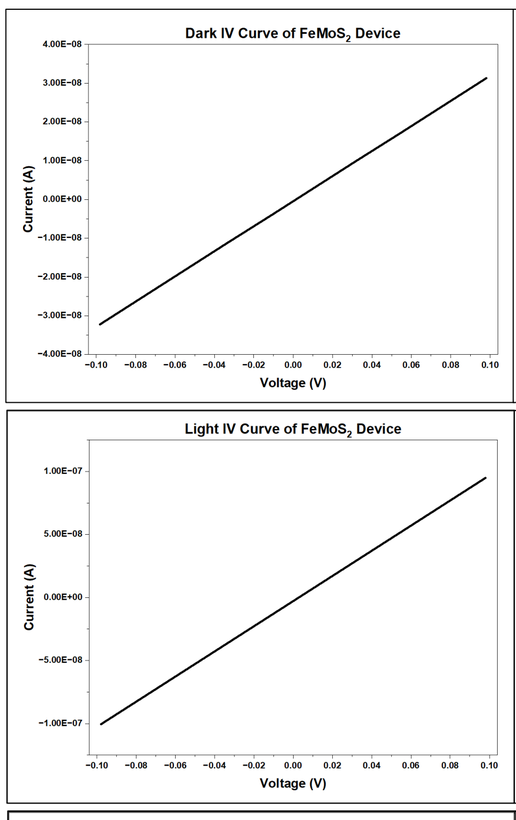


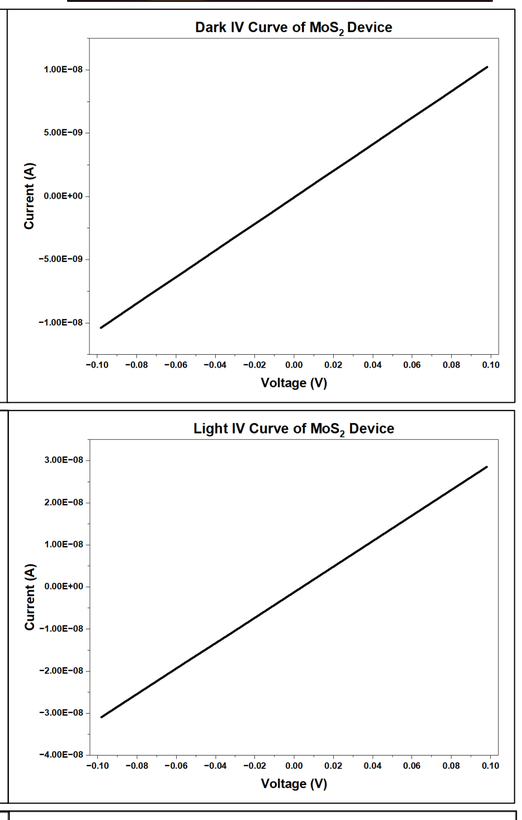
Results - Fe/MoS2 FET IV Characterization

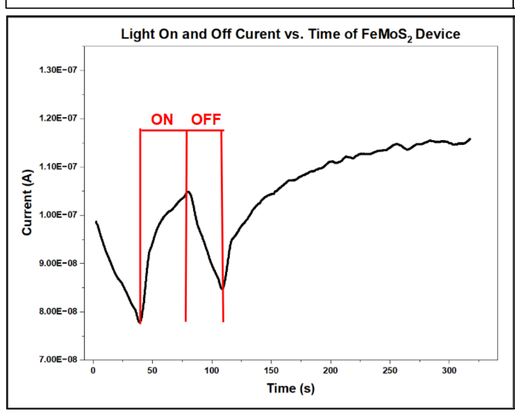


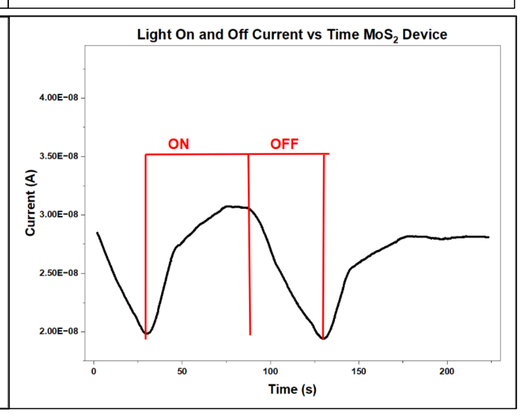












Discussion

This project provides a comprehensive IV characterization of Fe/MoS2 FET devices. Key findings include dark IV measurements, light IV measurements, and light on and off current measurements with a light power 15.844 nW. The FeMoS2 FET devices have an overall lower resistance and higher increase in current during the light on and off current test.

Limitations: The project's limitations include the absence of different tubes used in the contact CVD growth process. As well, budget constraints to fabricate a gas sensing apparatus for gas sensing tests.

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