Temperature Dependent Low Frequency Noise of Few Layer MoS$_2$ Grown by Chemical Vapor Deposition

- Device Configuration
- Motivation of Study and Intro to Noise
- Results and Discussion
- Summary

Presenter: Junao Cheng
Great thanks to Prof. Lu and all other group members
Device Configuration

Few Layer MoS$_2$ on Sapphire (Al$_2$O$_3$)
Source and Drain Ohmic Contacts

Cross-section TEM image of 6 nm channel
Motivation of Study: Carrier Transport Study
Motivation of Study: DC I-V study on mobility and carrier concentration

\[ I = \frac{q\eta \mu L}{d} V + \frac{2\varepsilon \mu L}{\pi d^2} V^2 \]

- **Measured**
- **Linear Fit Line**
- **Polynomial Fit Line**

Fit to SCLC region

Fit to Ohmic region

- [Graph showing current vs. DC bias (V)]

- [Graph showing carrier concentration and mobility vs. temperature (K)]
Noise in semiconductors

- Spontaneous Fluctuation of the System
- Applied in defining physical limit of measurement, measuring physical constants.
- Low Frequency Noise as a major source of Phase Noise.

Power Spectrum Density is used to study the performance.
Confirmation of Mobility Fluctuation Mechanism

\[
\frac{S_l}{I^2} = PSD_{Norm} = \frac{q V \alpha_H \mu}{f d^2 I} = k \cdot I^{-1}
\]
Confirmation of Electron Hopping Transport

Kozub’s Dipolar model

\[
\frac{(\delta R)^2}{R^2} \propto \left( \frac{r s c}{L} \right)^3 \frac{P(T)T}{\omega} \left[ \frac{e^2}{kT} r l(\omega) \right]
\]

Uniform distribution of fluctuator density of states

\[
\frac{S_I}{I^2} = \frac{(\delta R)^2}{R^2} \propto T^{-3/2}
\]

Fitted linear slope: 10 Hz \( k = -1.45 \pm 0.31 \), 100 Hz \( k = -1.26 \pm 0.47 \)
Summary

• The low frequency noise spectrum gave evidences of various transport results under different temperature regime

  Variable Range Hopping noise was proved at 75K<T<180K
  Mobility Fluctuation Mechanism was proved at T>180K

• Further investigations would be required for the study of such materials on three terminal devices