Microwave Spectroscopy of resistive Film Gated HIGFETS and MOSFETS

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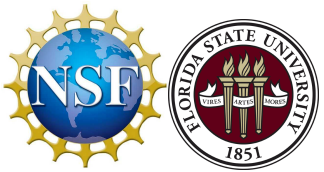

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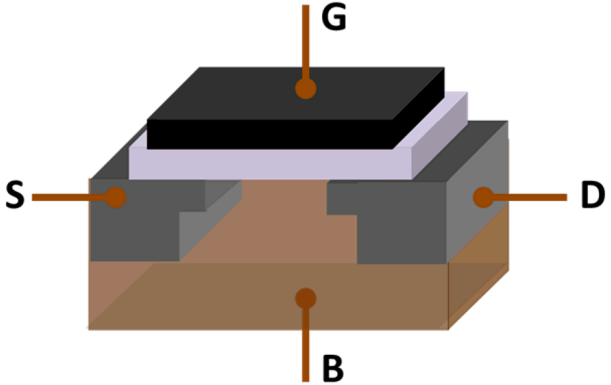
Outline

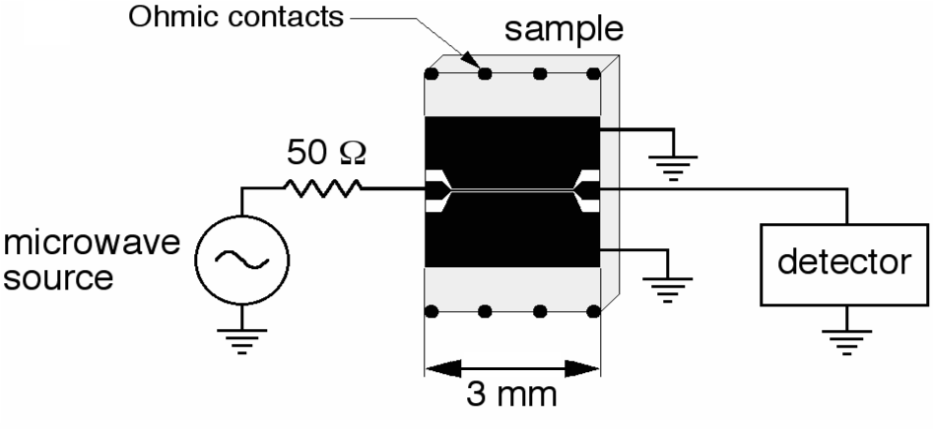
- What are Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFET) and Heterojunction Field-Effect Transistors (HIGFET)?
- How we modified them.
- Computational Modeling.
- Comparison of DC behavior to the model.
- Experimental evidence device is working.

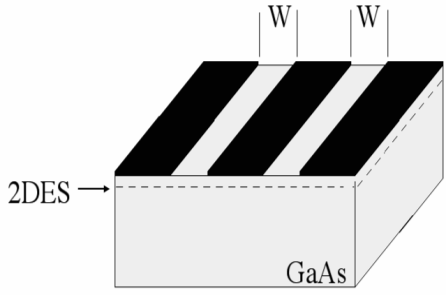
What are MOSFETS and HIGFETS, and how we modified them.



B = Base
S = Source
D = Drain
G = Gate

Measuring Technique

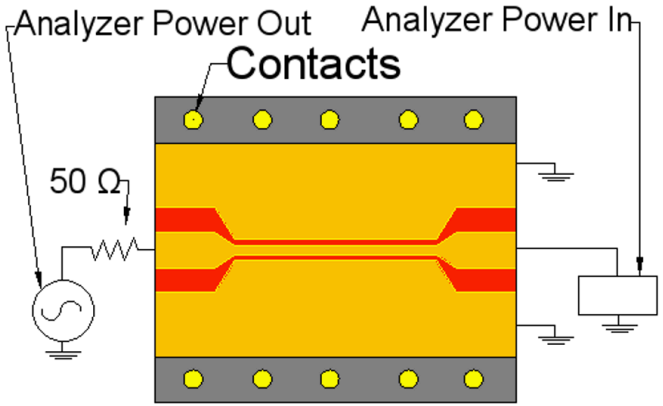




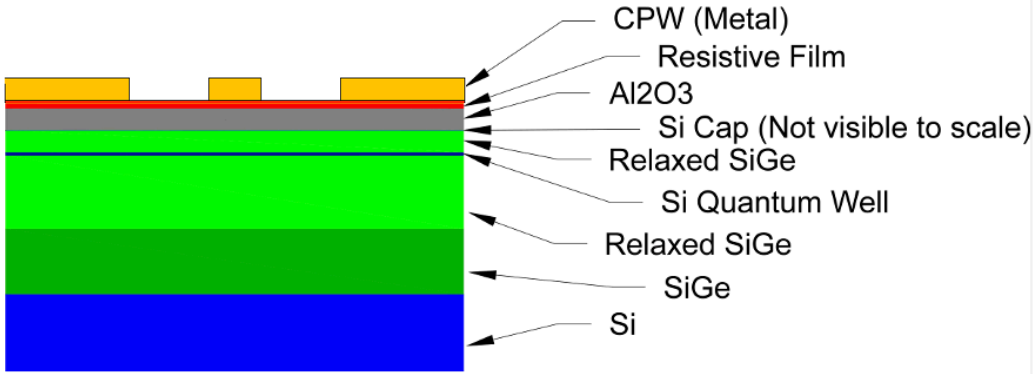
- Metal film makes coplanar waveguide (CPW) transmission line
- Center conductor driven, side planes grounded, “like coax”
- Re(σ_{xx}) from 2DES effect on signal

Our devices and how we measure them

Diagram of Coplanar Waveguide (CPW)

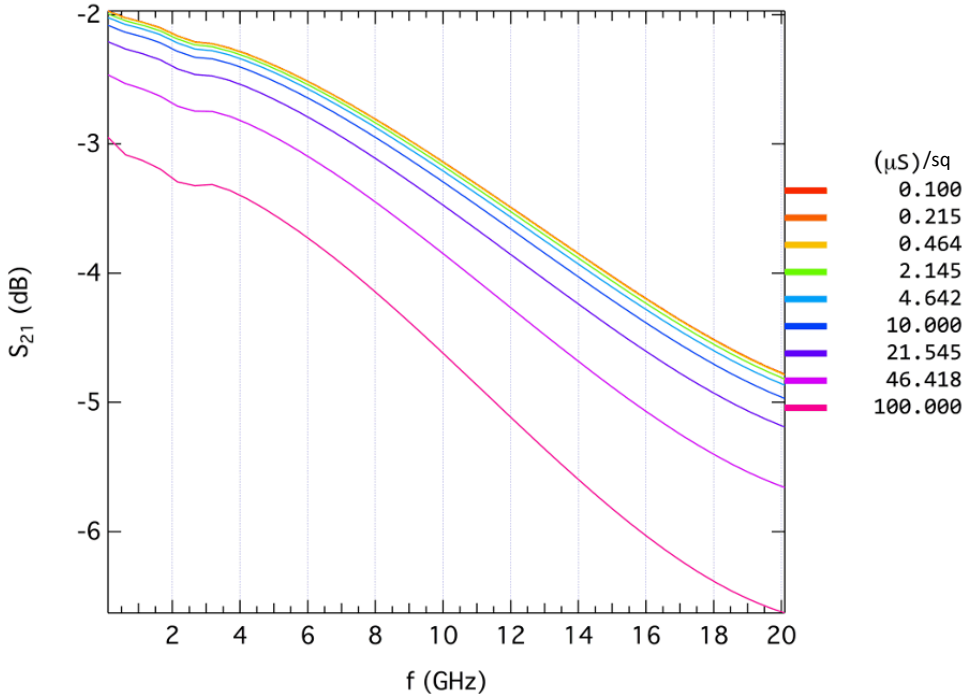


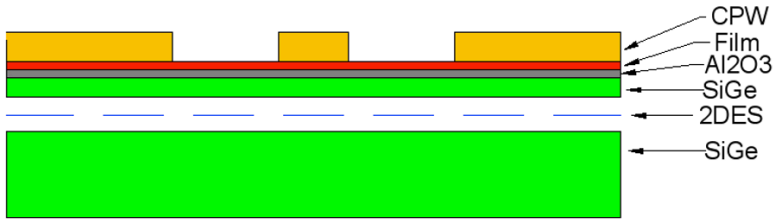
Scaled Cross Section of Device



Sonnet Modeling of Frequency Response

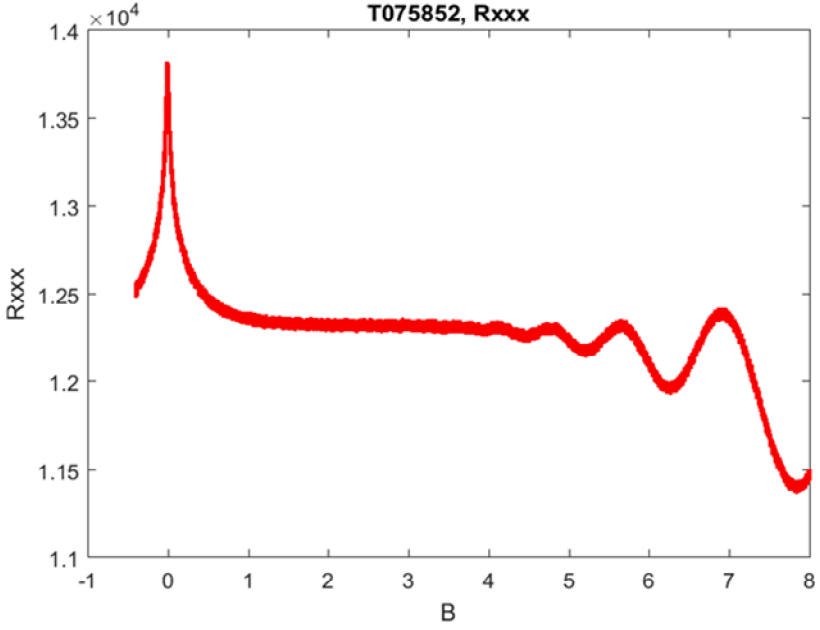
Sonnet Modeling of a HIGFET

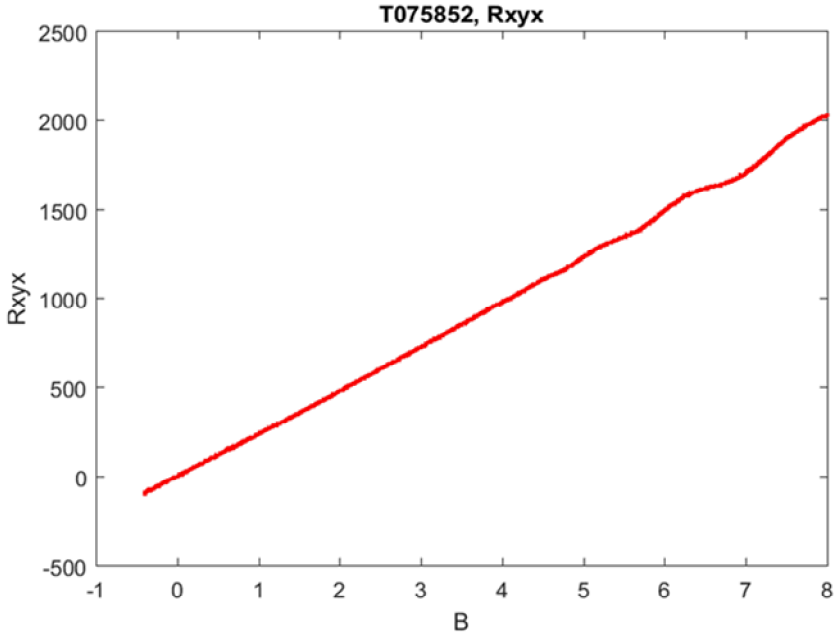




Example of Simplified Stack Used for Modeling, Not To Scale

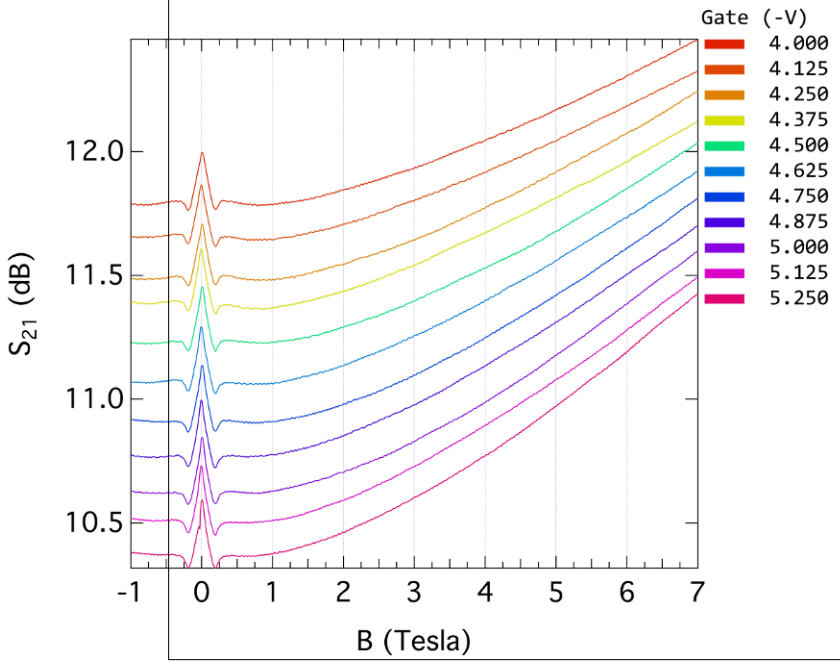
DC MOSFET Behavior



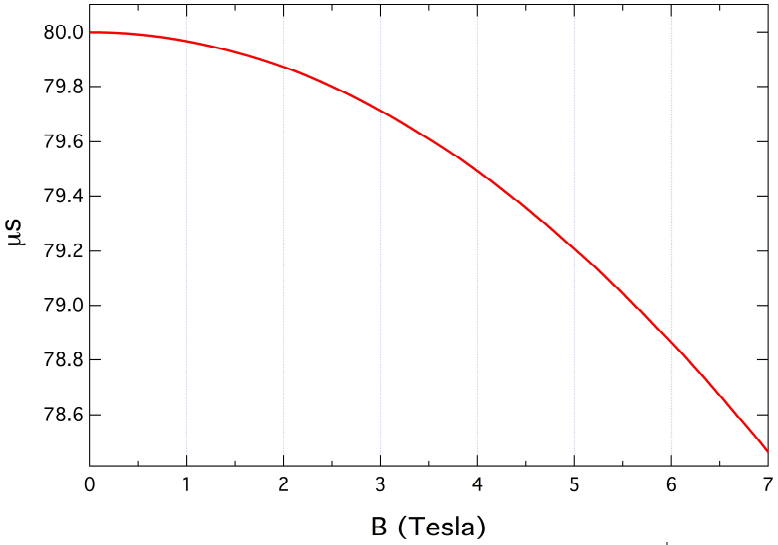


High B MOSFET

MOSFET Magnetic Field Response



Idealized Conductivity



$$\ln|S_{21}| \sim -\sigma_{xx} = -\frac{\rho_{xx}}{\rho_{xx}^2 + \rho_{xy}^2} \qquad \rho_{xy} = \frac{B}{ne}$$

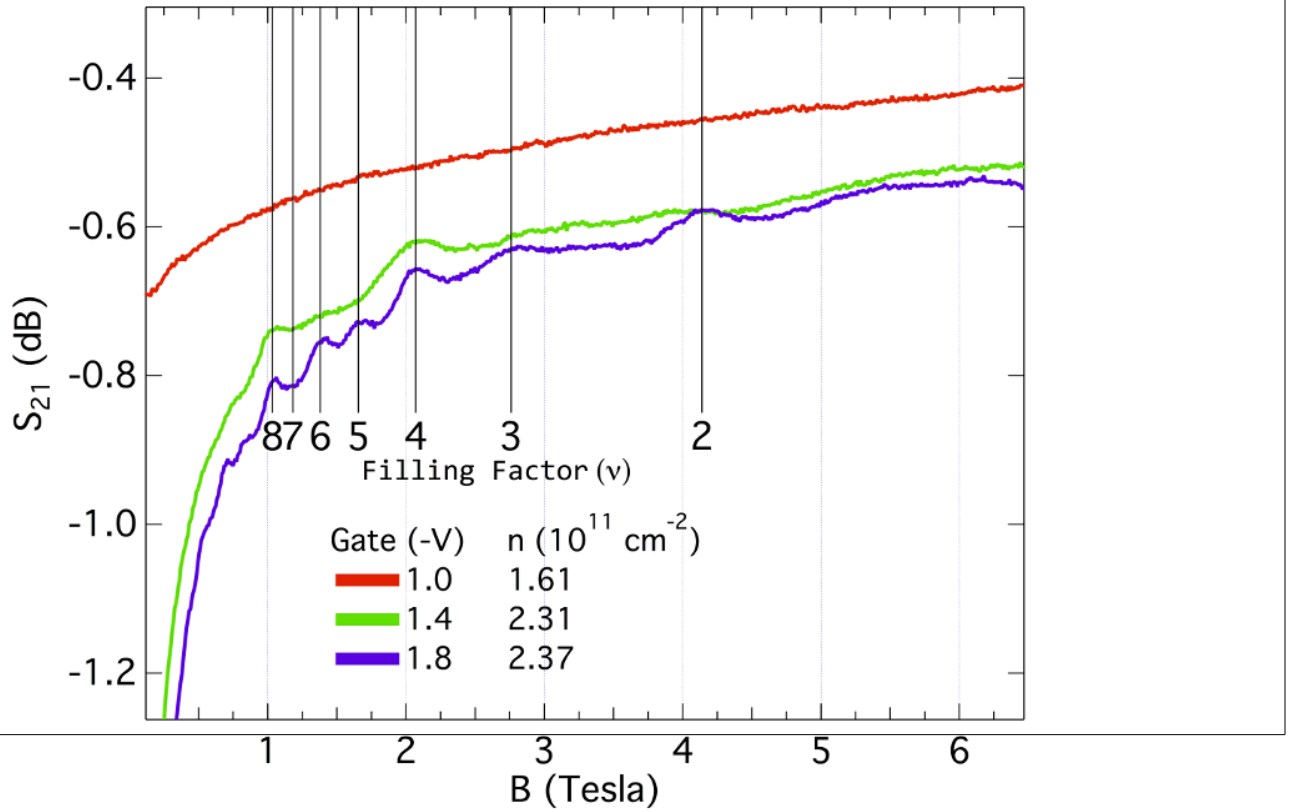
Quantum Hall in a HIGFET

Landau Filling

$$\nu = \frac{nh}{eB}$$

Mobility

$$\mu = \frac{\sigma}{ne}$$



Summary

- Add resistive film and CPW to devices.
- Resistive film prevents inhomogeneity in the 2D arising from the CPW, but also loads the CPW.
- Sonnet predicts limited frequency response of the device.
- Experimental data confirms Sonnet.
- So features seen in microwave spectroscopy should be from the 2D layer.
- Observed Quantum Hall proves microwave spectroscopy works.