Energy Harvesting Circuits and Prevalent Currents

Graphene-based Energy Harvesting
SURP 2021

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Setup

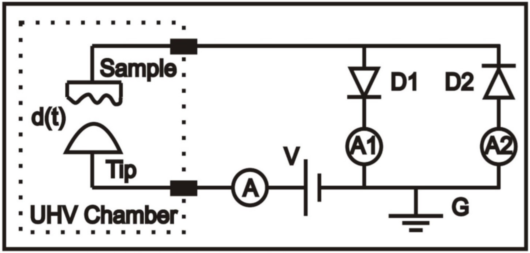
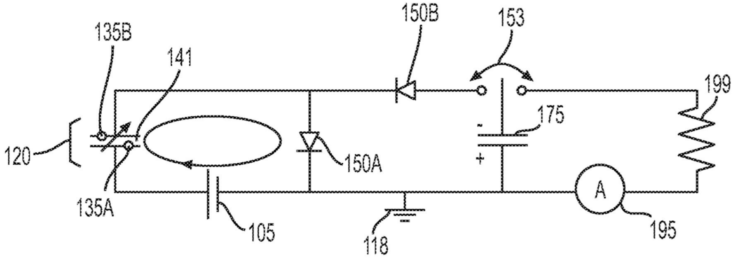


Figure: STM & Circuit Setup

Circuit in Patent



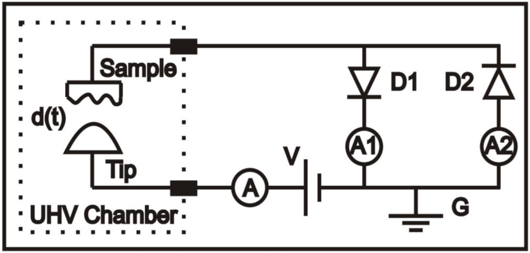
$$Q_{ch}(t) = \frac{\epsilon_0 A f \langle \Delta d \rangle}{d_0^2} V_{stm} t + k G_{stm} \langle \Delta d \rangle I_{stm} t$$

STM Configuration

- STM in point-mode of operation : fixed (x, y)
- Constant Height Mode : fixed V_{STM} & fixed z
- Tunneling Current is measured.
- When the bias voltage (V_{STM}) is increased, the graphene approaches the STM tip, while, on the other hand, when the tunneling current is increased the graphene contracts from the STM tip.

Currents

- Two Diodes to isolate Displacement Current from Tunnelling Current



- To measure displacement current, STM tip is backed away from graphene until no electrons can tunnel through.

Measurements

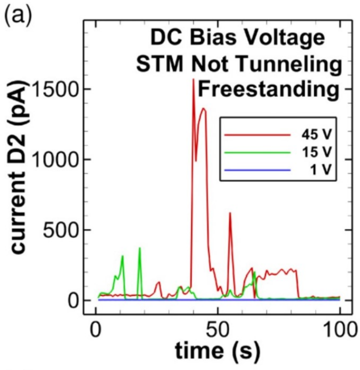


Figure: Current through D2 at various Bias Voltages

Displacement Current

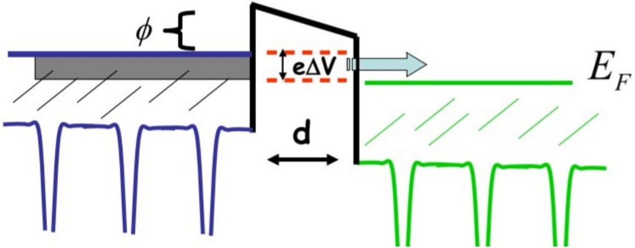
- Modelling Capacitance :

$$C_0(V) = \frac{\epsilon A(V)}{d} \; ; C(x) = \frac{C_0}{1 + \frac{x}{d}}$$

- Displacement Current, i_d

$$I_{\Delta C}(t) = \frac{\epsilon_0 A}{d_0^2} \Delta d(t) V_{STM} \times f$$

Tunnelling Current



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- Modelled the membrane atoms closer to the tip as a Brownian particle in a double-well potential, which represents the convex and concave curvature states of the ripple
- $U(x) = U_B \left(\frac{x^4}{4l^4} - \frac{x^2}{2l^2} \right)$
- Wiener Noise
- Ito-Langevin Equation for charge q through equivalent Resistor