

INVESTIGATION OF HYDROGENATED GRAPHENE/Si JUNCTIONS USING LOW-FREQUENCY NOISE SPECTROSCOPY

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Graphene/Si junctions have attracted considerable interest for electronic and optoelectronic applications due to the combination of graphene's high carrier mobility and optical transparency with silicon's well-established fabrication technology. Direct and catalyst-free growth of both pristine and hydrogenated graphene is possible by plasma-enhanced chemical vapor deposition (PECVD). However, hydrogenated graphene can be deposited at significantly lower temperatures [1]. Moreover, hydrogenation partially opens a bandgap, enabling interface passivation and reducing dark current, making hydrogenated graphene/Si heterostructures promising for high-performance Schottky photodetectors and sensors [2]. Low-frequency noise measurements are a sensitive and non-destructive way to assess device quality and reliability, and to gain insight into underlying physical mechanisms. To date, no scientific reports have been found in the literature on the low-frequency noise characteristics of hydrogenated graphene or devices based on it. The aim of this work was to investigate the low-frequency noise characteristics of hydrogenated graphene/Si junctions and to evaluate the influence of different graphene synthesis conditions, used during the same low-temperature PECVD growth of graphene, on the observed noise behaviour.

Electrical noise measurements were performed in the 10 Hz – 60 kHz frequency range under forward and reverse bias in a wide temperature range. Depending on the different synthesis conditions used during graphene's growth, the junctions exhibited 1/f, Lorentzian (g-r), or both types of voltage noise spectra (Fig. 1). For samples that exhibited pronounced Lorentzian-type spectral components, temperature dependent noise spectroscopy was performed in order to find the charge carrier characteristic time and activation energy of the observed g-r processes, which was compared with the theoretically calculated value in [3]. Statistical analysis across multiple junctions of the same synthesis conditions samples revealed the highest noise intensity in samples where graphene was synthesized with the highest H₂/CH₄ flow ratio at the same low temperature.

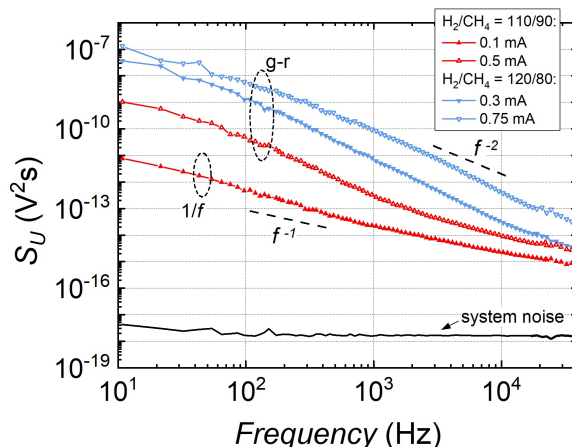


Fig. 1. Representative noise spectra at different forward currents for junctions with graphene, synthesized using different gas flow (sccm) ratios.

Keywords: fluctuations, graphene, low-frequency noise.

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- [1] Š. Meškinis, A. Lazauskas, Š. Jankauskas, A. Guobienė, and R. Gudaitis, "Advancing graphene synthesis: Low-Temperature growth and hydrogenation mechanisms using Plasma-Enhanced chemical vapor deposition," *Molecules*, vol. 30, no. 1, p. 33, 2024.
- [2] J. Cong, A. Khan, P. Hang, L. Cheng, D. Yang, and X. Yu, "High detectivity graphene/si heterostructure photodetector with a single hydrogenated graphene atomic interlayer for passivation and carrier tunneling," *Nanotechnology*, vol. 33, no. 50, p. 505201, 2022.
- [3] P. Wang et al., "Radiation-Induced Charge Trapping and Low-Frequency Noise of Graphene Transistors," *IEEE Trans. Nucl. Sci.*, vol. 65, no. 1, pp. 156–163, 2018.