Suspended Graphene as a Platform for Studying $1/f$ Noise

Masahiro Kamada[1], Antti Laitinen[1], Weijun Zeng[1,2], Marco Will[1], Jayanta Sarkar[1], Kirsi Tappura[3,4], Heikki Seppä[3], Sheng-Shiuan Yeh[5], and Pertti Hakonen[1,2]

[1] *Low Temperature Laboratory, Department of Applied Physics, Aalto University, Finland*

[2] *QTF Centre of Excellence, Department of Applied Physics, Aalto University, Finland*

[3] *Microelectronics and quantum technology, VTT Technical Research Centre of Finland Ltd., Finland*

[4] *Microelectronics and quantum technology, VTT Technical Research Centre of Finland Ltd., QTF Centre of Excellence, Finland*

[5] *International College of Semiconductor Technology, National Yang Ming Chiao Tung University, Taiwan*

Quantum devices in nanotechnology are plagued by $1/f$ noise. Monolayer graphene devices are no exception, even though they have been found to exhibit very small noise. Suspended graphene devices have been found to provide the lowest noise since they can be made nearly perfectly clean without defects in the nearby substrate. Several physical mechanisms have been suggested as the origin of the $1/f$ noise in graphene, either via fluctuations of the chemical potential or directly via mobility fluctuations. In addition, contact noise has been found to be relevant in many cases.

In our work [1,2], we have tested fundamental aspects of noise theories based on mobile impurities. We generate $1/f$ noise by adsorbing extra neon atoms onto a graphene membrane. Since the background impurity scattering is almost non-existent in suspended graphene, even weak scatterers such as neon atoms may make a difference in the impurity scattering, and thereby modify noise substantially. We find that, below about 15 K, Ne atoms are bound to graphene, and detailed studies on the effect of surface diffusion on the noise can be performed. We observe that the power exponent γ of the noise $S_I \propto 1/f^\gamma$ changes from 1.4 to 1.2 upon warming from 4 K to 10 K due to diffusion of neon atoms and their clustering/declustering.

Furthermore, we have investigated magnetic field dependence of the measured noise and observed a clear suppression of noise as a function of B, with a minimum around $\mu_0 B \simeq 1$, where μ_0 denotes zero-field mobility of charge carriers. This observation of suppression, made in the Corbino geometry, provides strong evidence of mobility fluctuations as our results can only be explained by correlated fluctuations in the radial and azimuthal mobility components.

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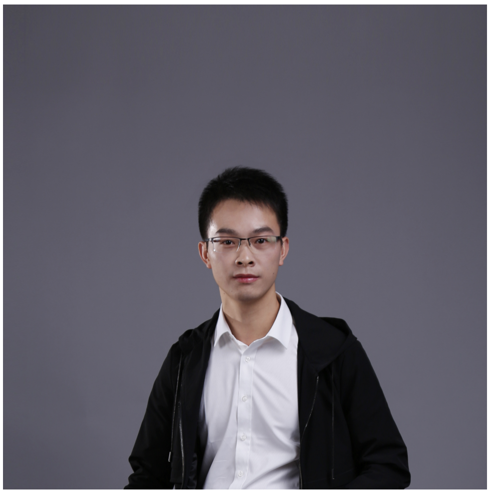
[1] M. Kamada, A. Laitinen, W. Zeng, M. Will, J. Sarkar, K. Tappura, H. Seppä, and P. Hakonen, Nano Lett. **21**, 7637-7643 (2021), doi: 10.1021/acs.nanolett.1c02325.

[2] M. Kamada, W. Zeng, A. Laitinen, J. Sarkar, S-S. Yeh, K. Tappura, H. Seppä, and P. Hakonen, arXiv:2112.11933.



Weijun Zeng