Gate-tunable graphene-based Hall sensors on flexible substrates with increased sensitivity

Burkay Uzlu [1,2*], Zhenxing Wang[1], Sebastian Lukas[1,2], Martin Otto[1], Max C. Lemme[1,2] and Daniel Neumaier[1]

[1]*Advanced Microelectronic Center Aachen (AMICA), AMO GmbH, 52074 Aachen, Germany*
[2]*Chair of Electronic Devices, RWTH Aachen University, 52074 Aachen, Germany*
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Hall sensors are widely used in application fields like consumer electronics and automotive for position precision and switching applications. Key parameters of Hall sensors are the current related (S_i), the voltage related (S_v) sensitivities and the magnetic resolution (B_{min}). Graphene, because of its very high mobility μ and low charge carrier concentration n ($S_v \approx \mu$ and $S_i \approx 1/n$) as well as its mechanical flexibility, appears to be an ideal material for Hall sensors. Previously, graphene based Hall sensors outperforming all other technologies on flexible substrate were demonstrated. However, the sensitivity of flexible graphene Hall sensors is not yet outperforming rigid Hall sensors based on conventional semiconductors, at least if the graphene Hall sensor is fabricated with a scalable approach. [1,2]

In this work, we demonstrate a novel concept for operating graphene-based Hall sensors using an alternating current modulated gate voltage, which provides two important advantages compared to Hall sensors under static operation: 1) The sensor sensitivity can be doubled by utilizing both n- and p-type conductance. 2) A static magnetic field can be read out at frequencies in the kHz range, where the 1/f noise is lower compared to the static case. Sensitivity up to 0.55 V/VT and B_{min} down to $290\ \mathrm{nT}/\sqrt{\mathrm{Hz}}$ at 2 kHz gate frequency were found for Hall sensors fabricated on flexible foil. This significantly outperforms state-of-the-art flexible Hall sensors and is comparable to the values obtained by the best rigid III/V semiconductor Hall sensors.

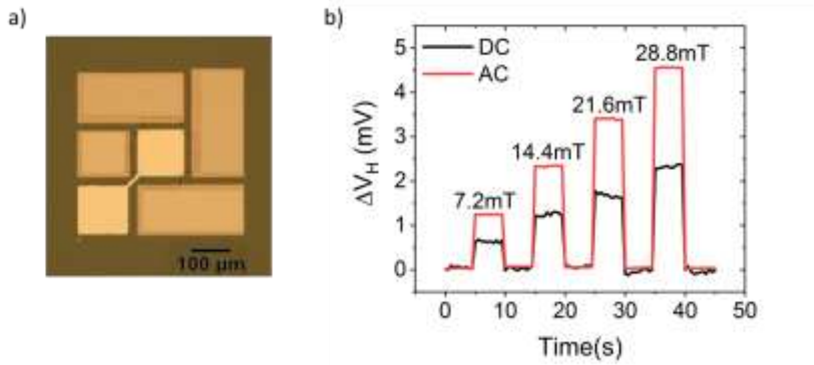

Figure 1: a) Microscope image of the top gated graphene Hall sensor on flexible substrate. b) Hall voltage under DC (black) and AC (red) operation.

References

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