Building blocks for graphene-based electronics

The excellent mechanical and electrical properties of graphene which make it highly suitable for use in Hall sensors have been theorised and realised in academic literature[1]. Paragraf has developed a commercially scalable graphene growth method [2] allowing for high quality graphene to be grown directly on device substrates, producing highly sensitive Hall sensors.

The first products were specifically designed for cryogenic and high field applications, where accurate measurements in extremely high fields of 30 T (figure 1) and at cryogenic temperatures are possible simultaneously. Other high performance Hall sensors, such as silicon with integrated electronics and 2DEGs, show significant non-linearities and fail above a few Tesla and at cryogenic temperatures[3]. Now the next stage of development is to address larger Hall sensor markets, such as automotive and aerospace, where continuous use at high temperatures, typically 125°C and above, is a key requirement.

Graphene is known to be sensitive to its surrounding environments, therefore the choice of materials and deposition methods will have an impact on the intrinsic electrical properties of graphene post-fabrication as well as on its performance under different testing conditions. Fundamental investigations into a range of materials and methods have increased our understanding of graphene's performance in several configurations (figure 2) allowing commercially viable devices to successfully be developed.

We discuss the current research into the high temperature stability of graphene Hall sensors, including the growth challenges and the impact of material interfaces on the fabrication of such heterostructures for device applications.

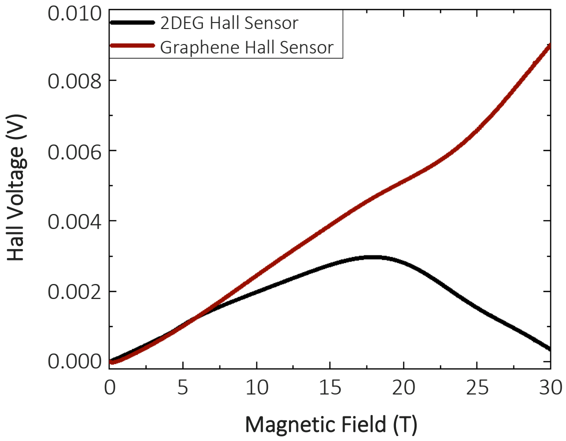

Figure 1. Hall voltage response at 1.5 K of Paragraf's graphene Hall sensor and a commercially available 2DEG sensor between 0 and 30 T. Paragraf's sensor shows a linear response over the full field range, whereas the 2DEG performance degrades significantly above 15 T.

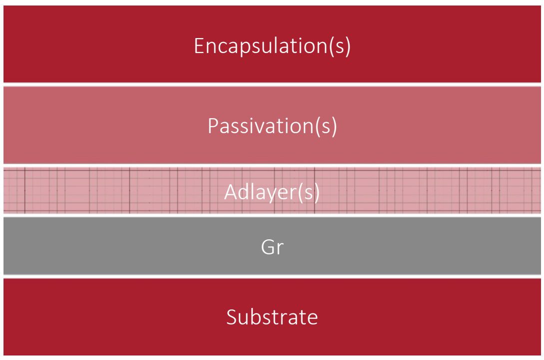

Figure 2. Schematic representation of a typical heterostructure employed during the development of Paragraf's graphene Hall sensor devices.

References

[1] Song, G. et al., Communications Physics, 2.1, 1-8, (2019)
[2] Thomas, S. "A method of producing a two-dimensional material", WO2017029470
[3] Popović, R. S. et al., Solid-state electronics 31.12 1681-1688, (1988)

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