**Direct electrical characterisation of graphene on germanium: challenges and opportunities.**

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## Abstract

The recent demonstration of large-scale deposition of high-quality graphene directly on a Ge substrate [1-3] has attracted a great interest in the use of the graphene/germanium system for device applications. However, device processing and electrical characterisation is typically obtained after transfer of graphene onto another substrate [1,2]. Recent encouraging progress towards the electrical characterisation of as grown graphene-on-germanium was obtained by using co-linear scanning tunneling microscopy tips to measure four probe resistivities [3].

Here we report the fabrication of Hall Bars (Fig. 1) directly etched in the graphene on germanium and present electrical characterisation at cryogenic temperatures and in a magnetic field. We discuss challenges and opportunities offered by this device architecture including electrical insulation between patterned devices and ohmic contact formation with low-resistivity at low temperature.

Overcoming of these challenges might open the door to hybrid graphene/germanium devices obtained in a true monolithically-integrated growth and fabrication process.

## References

[1] G. Wang, M. Zhang, Y. Zhu, G. Ding, D. Jiang, Q. Guo, S. Liu, X. Xie, P. K. Chu, Z. Di and X. Wang, Sci. Rep. **3** (2013) 2465.
[2] J.-H. Lee, E. K. Lee, W.-J. Joo, Y. Jang, B.-S. Kim, J. Y. Lim, S.-H. Choi, S. J. Ahn, J. R. Ahn, M.-H. Park, C.-W. Yang, B. L. Choi, S.-W. Hwang and D. Whang, Science **344** (2014) 286
[3] G. Lippert, J. Dąbrowski, T. Schroeder, M. A. Schubert, Y. Yamamoto, F. Herziger, J. Maultzsch, J. Baringhaus, C. Tegenkamp, M. C. Asensio, J. Avila and G. Lupina, Carbon **75** (2014) 104.

**Figure 1** Dry-etched Hall bar for direct electrical characterization of graphene-on-germanium.