Graphene devices and integration: A primer on challenges

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Graphene has been of interest to the physics and electrical engineering community alike since its isolation in 2004 and the Nobel Prize in 2010. There has been tremendous research effort on material evaluation and growth. Reported applications include RF transistors, ballistic devices, spin valves, gas sensors, optical modulators and in flexible electronics, to name a few. [1]

Whilst there have been several demonstrations of applications that are unique or dramatically enhance what is available in the market today, at this time efforts toward consistent/reliable graphene device fabrication and large scale integration are still immature. There are unique issues, independent of application, which affect graphene devices and integration efforts.

Contact resistance (R_c) is one such problem. Metal on graphene is in practice, a metal - semimetal system, so the traditional Schottky barrier induced R_c is zero. However measurements have yielded R_c to be a few hundred ohms and contact resistivity 10^{-5} to 10^{-6} Ω-cm^2. In comparison, contact resistivity of silicided Ni and Pt contacts used in industry have been measured to be as low as 10^{-8}Ω-cm^2.[2-4] Though there have been several papers evaluating metal- graphene interface interactions and R_c reduction mechanisms, there is still no known consistent solution. Mobility is another such instance. Mobility (μ) is used as a benchmark parameter for gauging the quality of a device based on differences in process, material, etc. In graphene (on substrate),μ has been reported to be as high as 60,000 cm2/Vs.[5] In addition to a known substrate, source and fabrication dependence, there have been preliminary studies that have shown mobility to vary as a function of channel dimensions. [6-10] This dependence contributes to an overestimation of mobility in small channel devices, which is rarely corrected for.

A first step towards utilization by industry entails comparison with what already exists and evaluating if the addition of graphene will help enhance an application by opening up new markets while not drastically increasing cost. A prerequisite towards evaluation is effort on correcting the known issues and fabricating devices that are consistent and reliable. The purpose of this talk is to highlight and discuss the issues that have been seen in this field and are as necessary to address as coming up with an application to begin with.

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