Transition Metal Contact Studies on Single- and Multilayer Graphene Ribbons

Maria Politou[a,b,*], Inge Asselberghs[b], Xiangyu Wu[a,b], Iuliana Radu[b], Cedric Huyghebaert[b], Zsolt Tokei[b], Stefan De Gendt[a,b], Marc Heyns[a,b]

[a] KU Leuven, 3001 Leuven, Belgium
[b] IMEC, Kapeldreef 75, 3001 Leuven, Belgium
*Maria.Politou@imec.be

Abstract

Graphene, an sp^2-bonded carbon sheet of one atom thickness, is extensively studied as a very promising material for post-Si electronics both for channel and for hybrid graphene/metal interconnects. Depending on the end application single- or multilayer graphene are of interest. In all cases, the issue of contacting graphene remains challenging and it is continuously attracting more and more attention.

In this work we are examining Pd, Au and Ni as metal contacts to single- and multilayer graphene ribbons. In addition, different contact schemes (top or edge contacts) are characterized (Fig.1a). The samples are fabricated with photolithography on commercially available large area synthetic (CVD) graphene. Single layer graphene (SLG) is purchased from Graphenea. Multilayer graphene of 5-8 layers (FLG) is purchased from ACS Material. The Transfer Length Method (TLM) is used for the extraction of contact resistivity (Rc*W) and sheet resistance (Rs).[1] From the obtained sheet conductivity (1/Rs) we can additionally extract mobility values for the ribbons.[2] All devices are measured at room temperature and ambient conditions. We focus on the building of statistics on datasets rather than individual device behavior and we are characterizing up to 30 TLM structures/sample.

A more metallic behavior is observed for the FLG samples compared to SLG (Fig.1b). Mobility values of ~1500cm²/V.s are calculated for SLG whereas the FLG ribbons are characterized by lower mobility values up to ~800cm²/V.s. The extracted Rc*W values around the neutrality point show that the same metal behaves differently as top or edge contact. Au appears as a good top contact to SLG, but a poor edge contact. Ni appears to be a better edge contact, whereas Pd results in low Rc*W values for both top and edge contacts (Fig.2). As the contacting scheme moves from a SLG-top contact to an FLG top or edge contact, an 80% decrease in the Rc*W values is observed, from ~10kΩ.um in average down to ~2kΩ.um (Fig.3, Pd contacts). We attribute these differences to the different graphene-metal interaction that takes place for the two contact configurations and the various metals (cf. also Ma et al.[3]). In the case of top contacts, the metals are interacting with the graphene π orbitals. The results on SLG and top contacts shown in Fig.2 are in accordance with our previous studies. In Politou et al.[4] we have reported that, in the case of top contacts on SLG, metals that form a weaker bond with graphene (such as Au) result in lower Rc*W values. Those metals do not disrupt the graphene cone with a chemical interaction. In the case of edge contacts the metals are interacting with the graphene σ orbitals. Our present results show that this edge configuration enhances the conduction and additionally that now it is the more reactive metal (Ni) that results in low Rc*W.

Figures

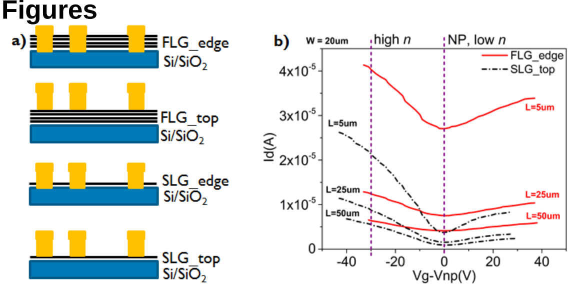

Fig.1a) Schematic of the different configurations under study. **b)** Higher current measured for FLG devices compared to SLG with same channel length L (Pd contacts).

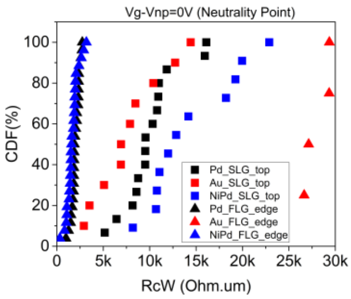

Fig.2 Rc*W values for different contact metals

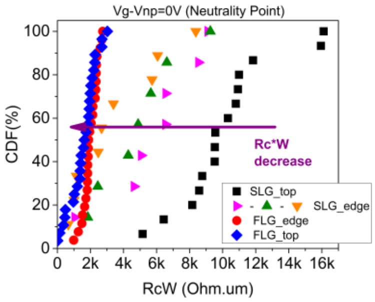

Fig.3 Rc*W values for different contact schemes (Pd contacts).

References

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