Spin injection and transport in functionalised graphene devices

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The influence of defects on spin transport in lateral graphene devices (spin valves) is a topic of significant current interest, with 'magnetic' sp3 defects in particular presenting opportunities to potentially control spin propagation [1,2]. However, finding a suitable platform for graphene functionalisation proved to be a challenge. We have demonstrated controlled and reproducible introduction of sp3 defects in monolayer graphene using chemical reaction with benzoyl peroxide (BPO). The latter can be easily and reliably controlled by irradiation with laser light, with defect density determined by the exposure. At typical separations of the order of 10 nm (0.01% coverage) the defects have a strong effect on spin transport, increasing the spin lifetime by as much as a factor 3. Unexpectedly, functionalisation also have a beneficial effect on spin injection, increasing the polarisation for standard aluminium oxide tunnel barriers from 5% to 10%, while having only a weak effect on spin diffusion. By comparing the quality (roughness) of aluminium oxide films forming on pristine and functionalised graphene with different defect densities, we show that sp3 bonded benzene molecules serve as nucleation centres for Al deposition, resulting in much smoother oxide films and finer grains. In turn, this increases the contact resistance and ensures mismatch-free conditions for spin injection, resulting in an overall improvement of the device performance.

References

[1] R. R. Nair et al, *Nature Communications* (2013) 4:2010.
[2] M. Wojtaszek et al, *Phys. Rev. B (2013)* **87**, 081402(R).

Figures

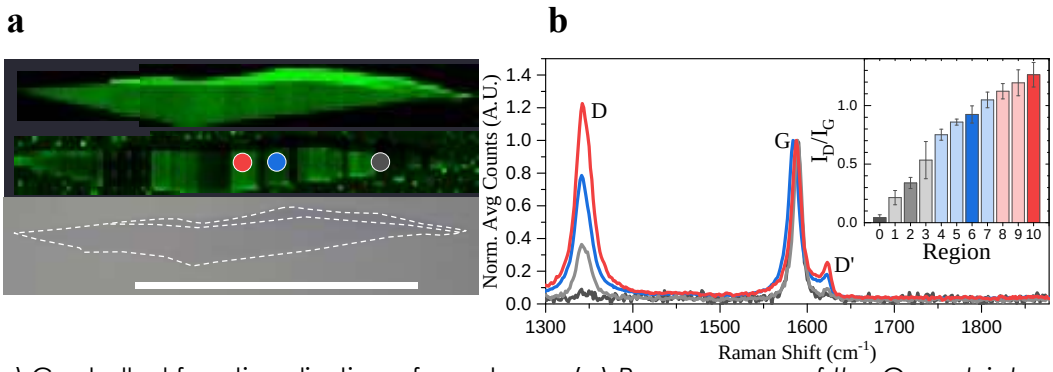

Figure 1: (a) Controlled functionalisation of graphene: (a) *Raman maps of the G peak intensity (top) and D/G intensity ratio (middle) for different irradiation doses. (b) Raman spectra (main panel) and D/G ratio (inset) corresponding to different functionalised regions in (a).*