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Going beyond copper

It's insulating nature as well as its optical transparency make sapphire an appealing substrate for graphene for a vast number of optoelectronic applications. However, direct growth of graphene on sapphire has proved to be challenging, usually requiring metal-catalysts or yielding defective graphene. Here, we report that high-quality monolayer graphene obtained via chemical vapour deposition (CVD) on the c-plane of Al_2O_3 (0001) substrates with a catalyst-free approach. The structural and chemical properties of the synthesized graphene are investigated by Raman spectroscopy, atomic force microscopy (AFM), low-energy electron diffraction (LEED) scanning-tunneling microscopy (STM) and low energy electron microscopy (LEEM). We are successfully able to scale up the process from batch to wafer scale (up to 4-inch wafer) keeping comparable quality and uniformity. The carrier mobility measured at room temperature is above 2200 cm^2/Vs. Besides, we can transfer full wafer graphene from sapphire to any other desired substrate by polymer-assisted technique. The presented metal-free CVD approach is of sure appeal in virtue of its implementation in a commercial system and it might be an ideal graphene production approach for front-end-of-line (FEOL) integration. Furthermore, by scalably yielding high-quality monolayer graphene, it might have a positive impact on many optoelectronic applications. Finally, industrially impacting in-line coating of graphene will be discussed.

Figures

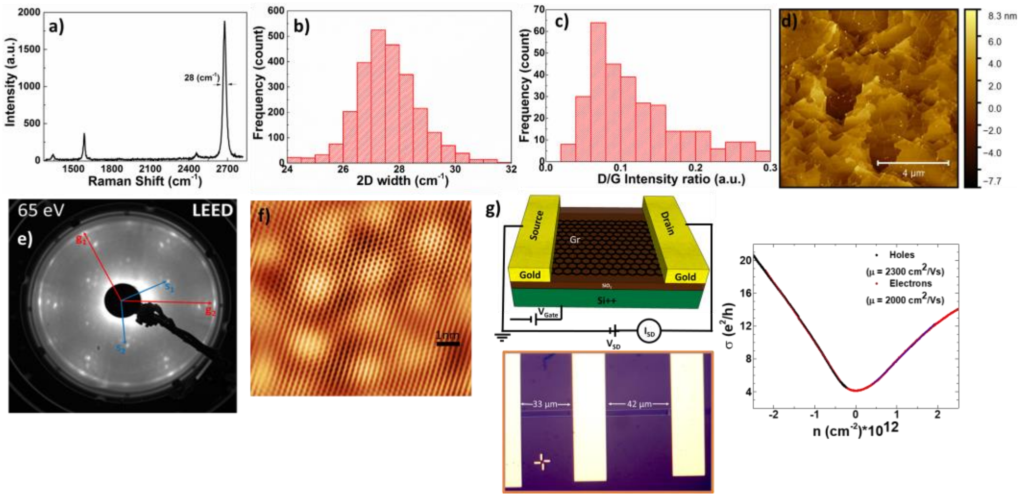

Figure 1: Graphene on sapphire characterization via (a) Typical Raman spectra of graphene (b) Peak width of 2D (c) D/G intensity ratio, (d) AFM (e) LEED at 65 eV; (f) 2D-FFT filtered STM topography image (g) Transport measurements.

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