GRAPHENE SYNTHESIS USING SOLID CARBON SOURCES

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The growth of graphene over large areas is a prerequisite for its use in industrial applications. The most commonly used method is currently chemical vapor deposition of hydrocarbons on transition metals such as nickel or copper [1,2]. We present an alternative route to large-area graphene synthesis on nickel using solid carbon sources and rapid thermal annealing [3].
Starting with thermally oxidized silicon substrates, two different approaches have been developed in which a carbon-rich layer can be deposited either before or after the deposition of a thin nickel film. In the first approach, a thin film of amorphous SiC is deposited on the substrate followed by the deposition of a nickel film. In the second approach the nickel layer is deposited first followed by spin coating a thin polymer film (polyvinyl alcohol in our case) onto the nickel surface. In both cases graphene is grown on the nickel surface by annealing the sample at 800 to 1100°C in nitrogen atmosphere for 30 to 90 s. The thickness of the graphene layer ranges from predominately monolayer coverage to thicker layer of up to approximately 10 nm. For both carbon sources, the thickness and uniformity of the graphene layer depends on the annealing parameters as well as on the ratio of nickel to carbon source film thickness. In fig. 1 an SEM image of predominately monolayer graphene on nickel grown by annealing Ni on SiC is shown. Raman spectra taken from five locations of the same sample are depicted in fig 2, indicating uniform monolayer coverage with a low defect density.
The graphene was transferred to thermally oxidized silicon substrates by using the PMMA transfer method described in references [1] and [2]. Arrays of back-gated FETs with Ni contacts were fabricated. An optical microscope image of one such device is depicted in fig. 3, in this case with polyvinyl alcohol (PVA) as carbon source. The transfer characteristics of 8 different devices are plotted in fig. 4 with a field effect mobility ranging from 500 to 1400 cm^2/Vs measured at room temperature in nitrogen [4].

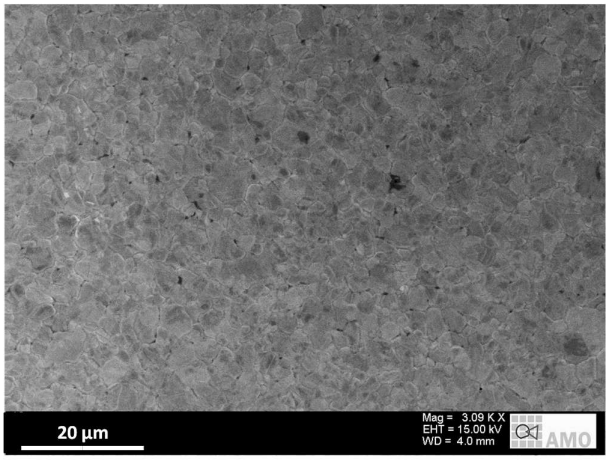

Figure 1: SEM image of predominately monolayer graphene on Ni grown by rapid thermal annealing of Ni on SiC.

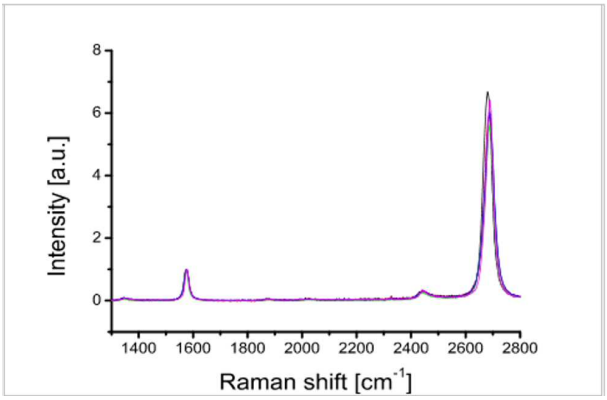

Figure 2: Raman spectra of five different locations of the sample shown in fig. 1.

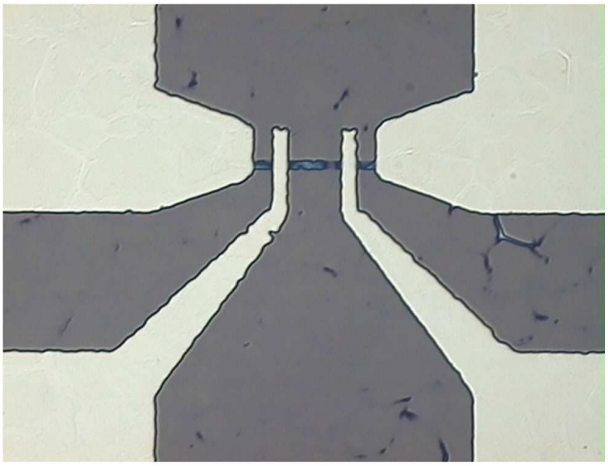

Figure 3: Optical microscope image of back-gated graphene FET with 90 nm SiO_2 as back gate dielectric.

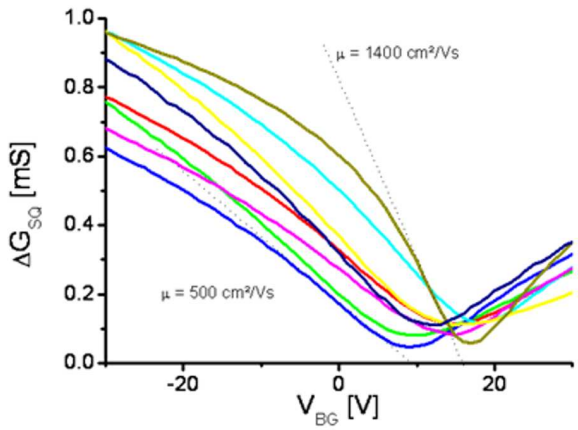

Figure 4: Transfer characteristics of 8 different devices on a sample with graphene grown from rapid thermal annealing of PVA on Ni.

References

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