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In situ TEM electrical characterisation and patterning of graphene

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Introduction

- Transmission electron microscopy is an excellent characterisation tool, able to obtain information about the graphene structure on an atomic scale
- It can also be used to pattern the graphene through (1) knock-on damage from the beam, (2) etching with oxygen (in an environmental TEM), (3) nanoparticle etching
- Here we present our preliminary work with graphene in-situ TEM

TEM Platforms

We have fabricated a variety of chips that are able to measure electrical properties and heat up.

Graphene Constriction

1. Using knock-on damage we can structure the graphene by focusing the beam to a small area as possible, in this case forming a constriction.

2. After sculpting we swept the voltage until the constriction broke

3. High resolution images of the broken area shows indications of heating

Graphene Transfer

We transfer graphene using the “wedging” method with cellulose acetate butyrate (CAB). We have reproducibly obtained graphene suspended over 15 µm trenches on our TEM platforms.

Cleaning Graphene

Current annealing in normal atmosphere

In-situ TEM by the on-chip heater

The work leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° FP7-604000

Twisted Bilayers

We have fabricated samples of stacked incommensurate monolayers (“twisted bilayers”) using wedging transfer to place a graphene flake on top of another. The stack is then transferred to the TEM platform.

Twisted Bilayers

We have seen a diode-like behavior in this sample with straight edges