Charge Transfer Properties Through Graphene Layers in Gas Detectors

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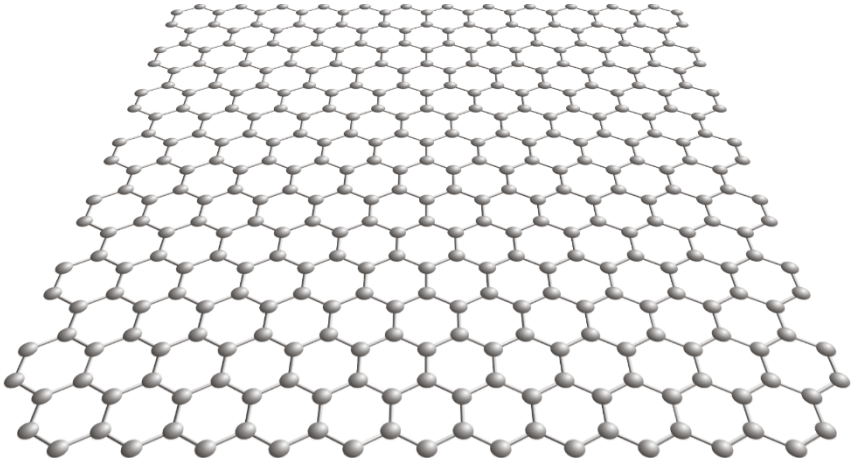
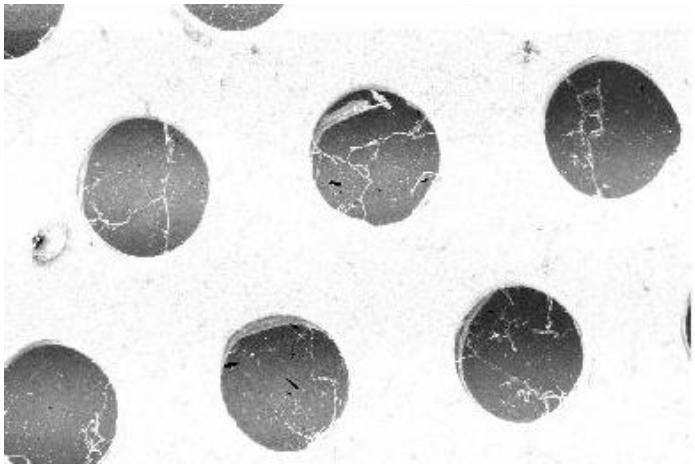
Graphene Layers in Gas Detectors

- Goal: create a device fully transparent to electrons and fully opaque to ions
- Graphene is smallest possible mesh with pore size < 1 Å
- Study of charge transfer through graphene layer suspended on Cu meshes





Outline

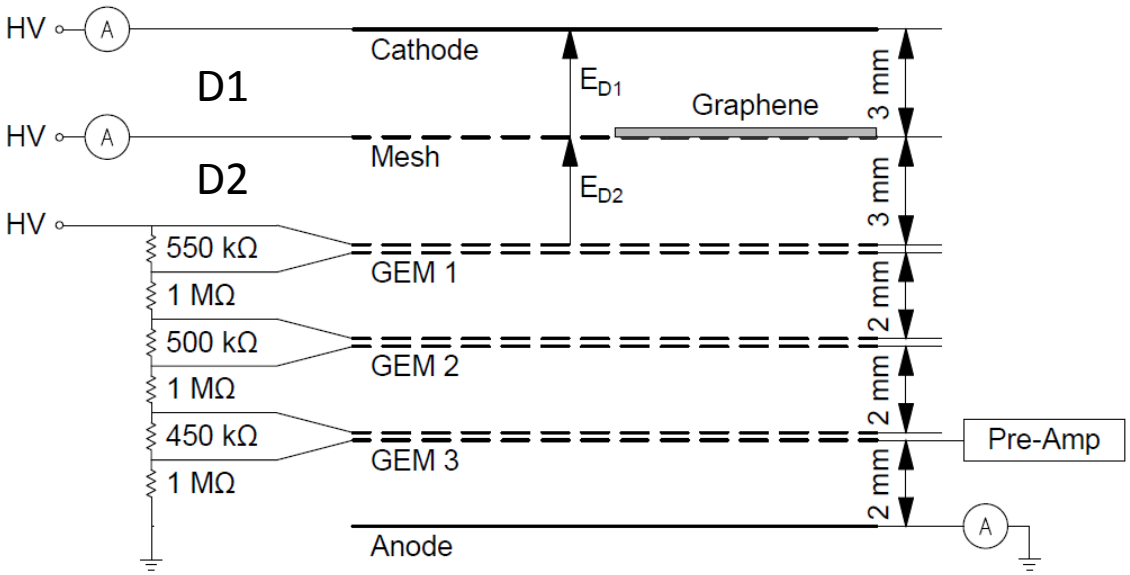
- Motivation
- Setup
  - Graphene Transfer
- Results
- Outlook

Motivation

- Best case scenario: create a membrane which is fully transparent to electrons and fully opaque to ions
- More realistic: create a membrane which is mostly transparent to electrons and mostly opaque to ions

Setup

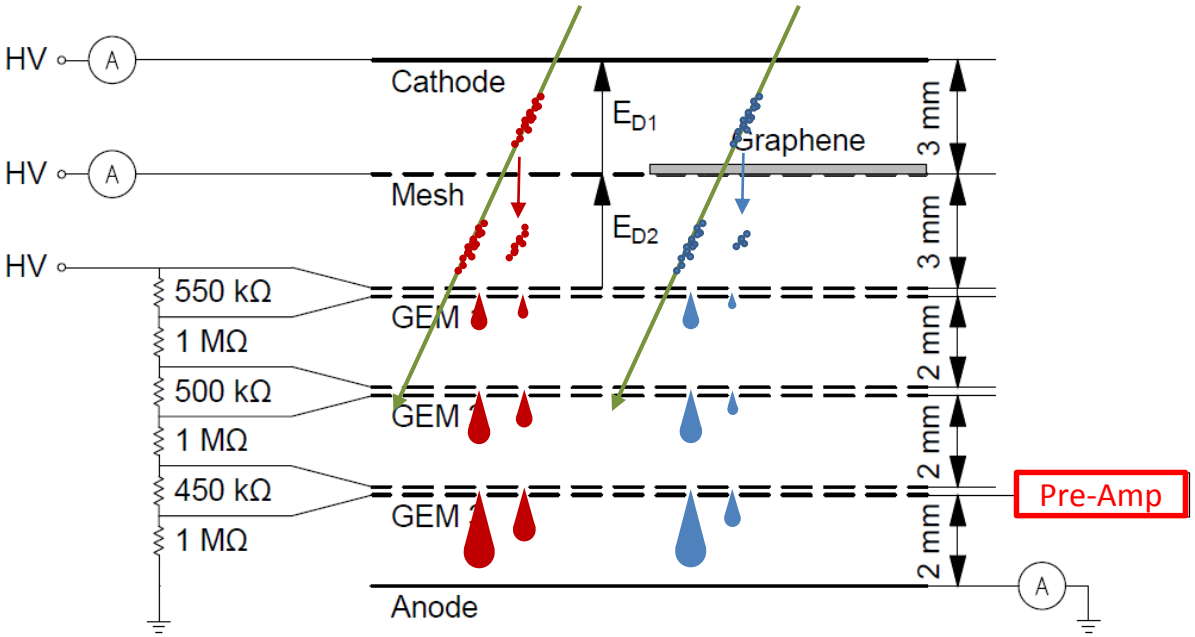
- Standard GEM setup with additional conversion volume on top
- Mesh partly covered with graphene layer between conversion volumes
- GEM powered through resistor divider
- Cathode and Mesh powered individually

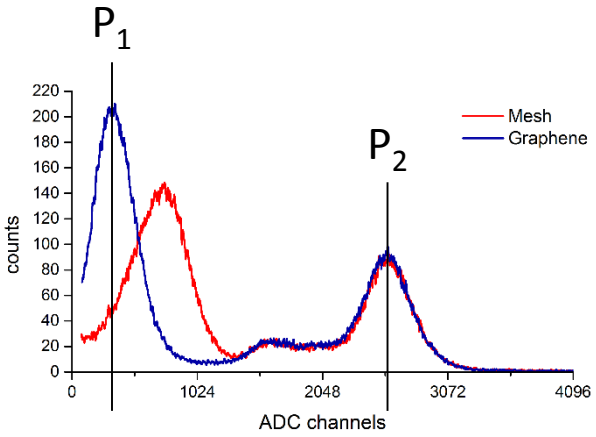


Electron Transparency

Ratio of peak positions from conversion below/above the mesh

$$T_{electron} = P_1/P_2$$

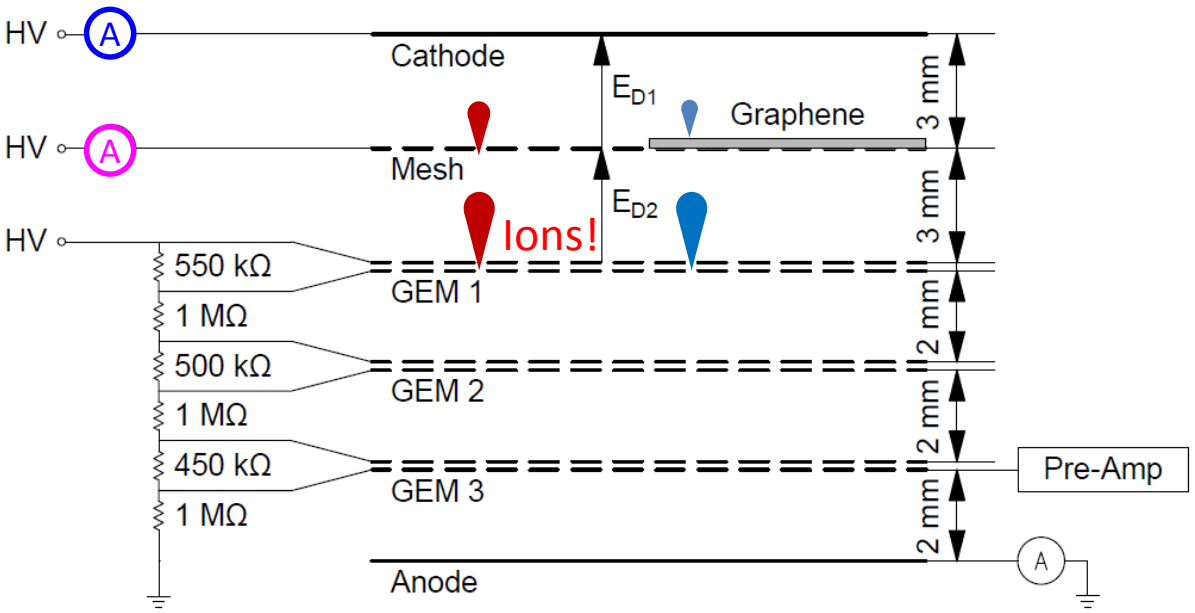


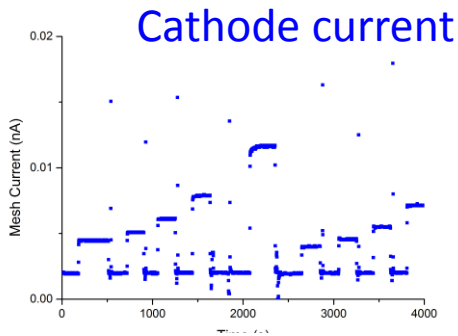


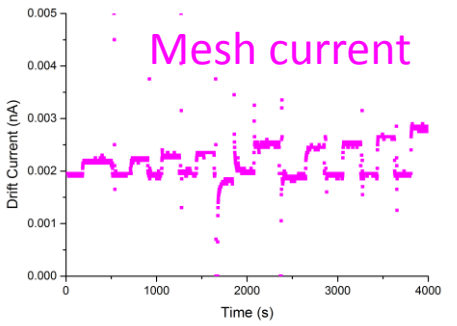
Ion Transparency

Current measurements

$$T_{ion} = I_{cath}/(I_{cath} + I_{mesh})$$

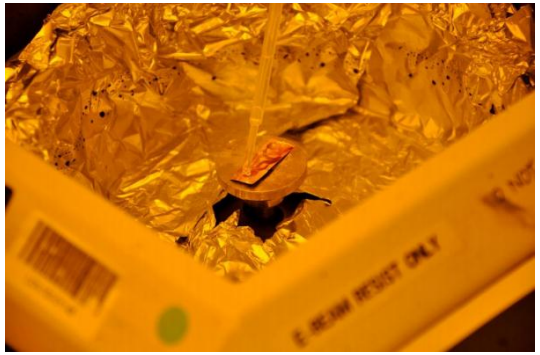






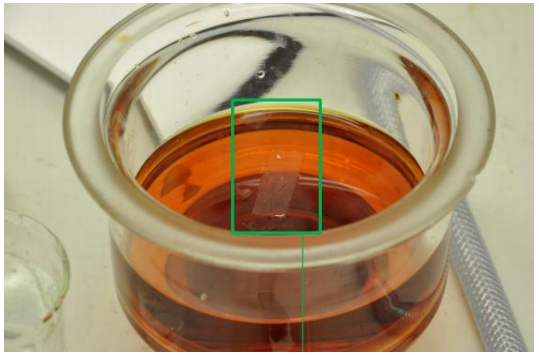
Graphene Transfer

CVD graphene on Cu foil



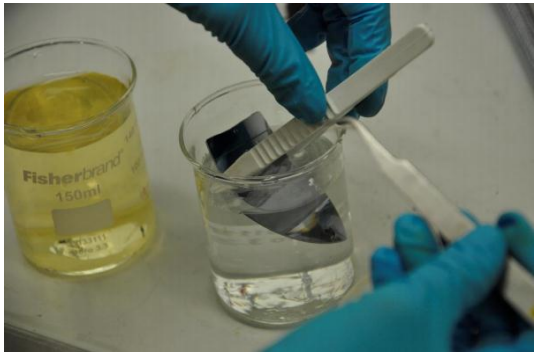
Small part of foil cut and spin-coated with PMMA

Put into etching liquid



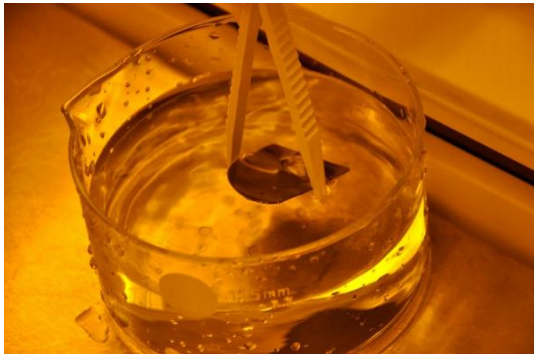
PMMA floating on liquid with graphene attached

Sample scooped out with Si waver

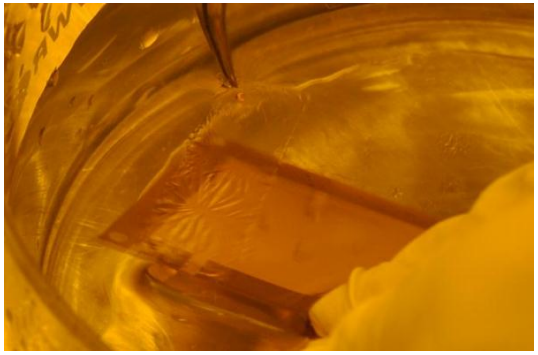


Two steps of cleaning with demineralized water

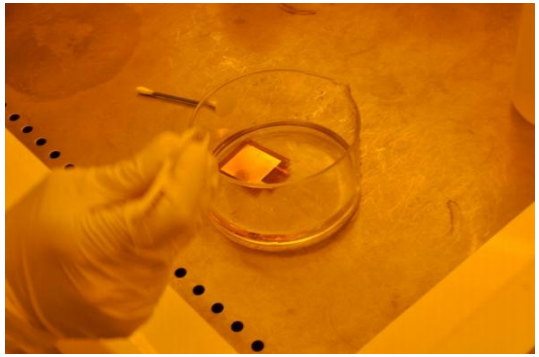
Graphene Transfer



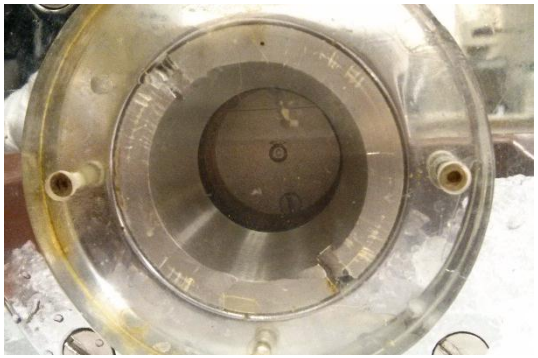
Moved to bigger beaker to enable transfer onto mesh



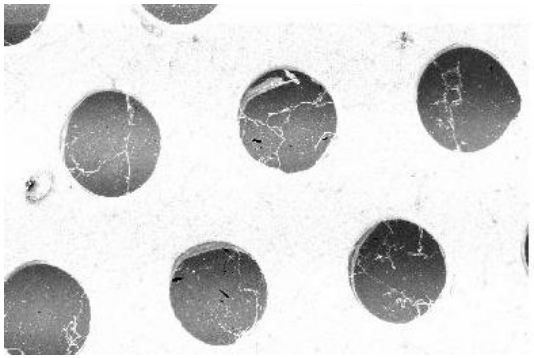
Sample scooped up with mesh

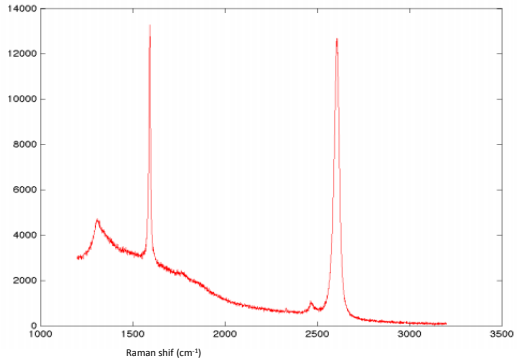


Sample put into aceton to dissolve PMMA



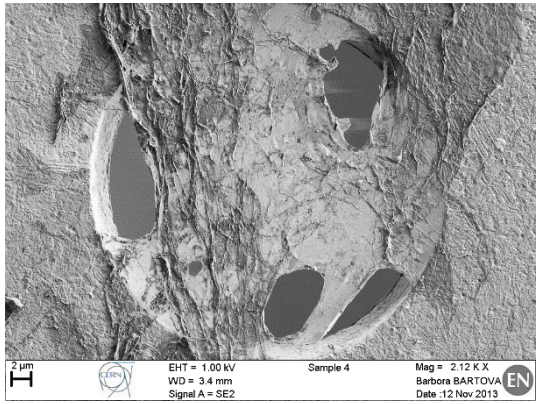
Sample dryed in Critical Point Dryer

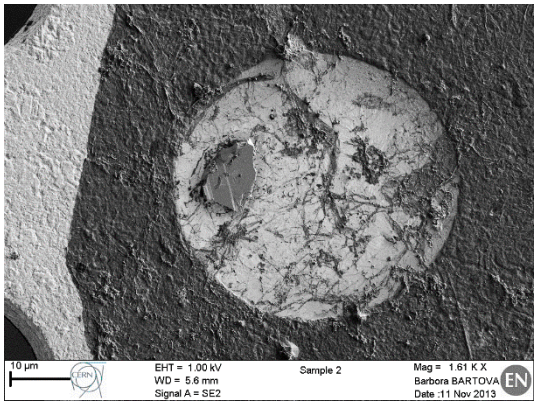


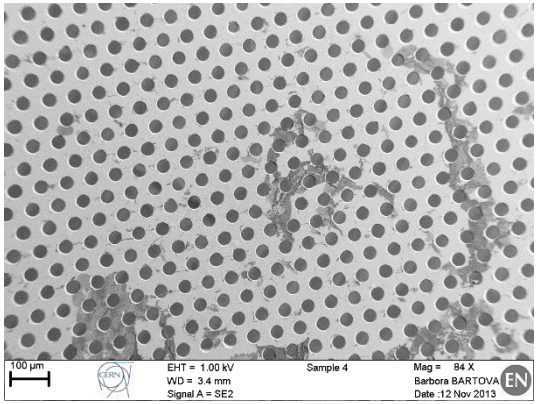


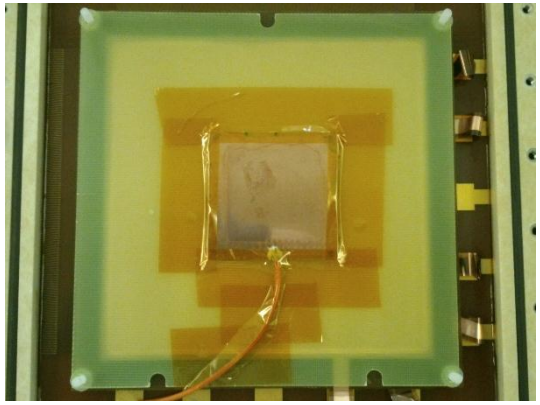
Sample checked with SEM to qualify coverage and with Raman Spectroscopy to check layer quality and PMMA contaminations

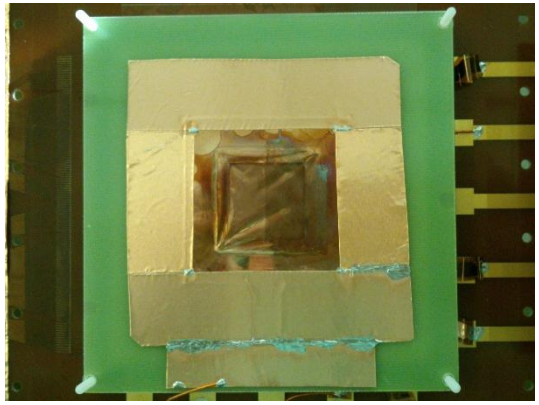
Graphene Transfer

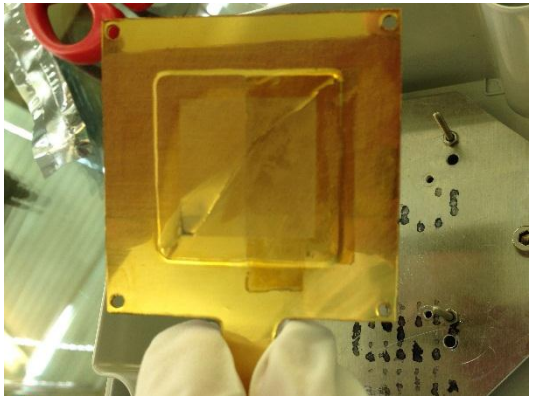




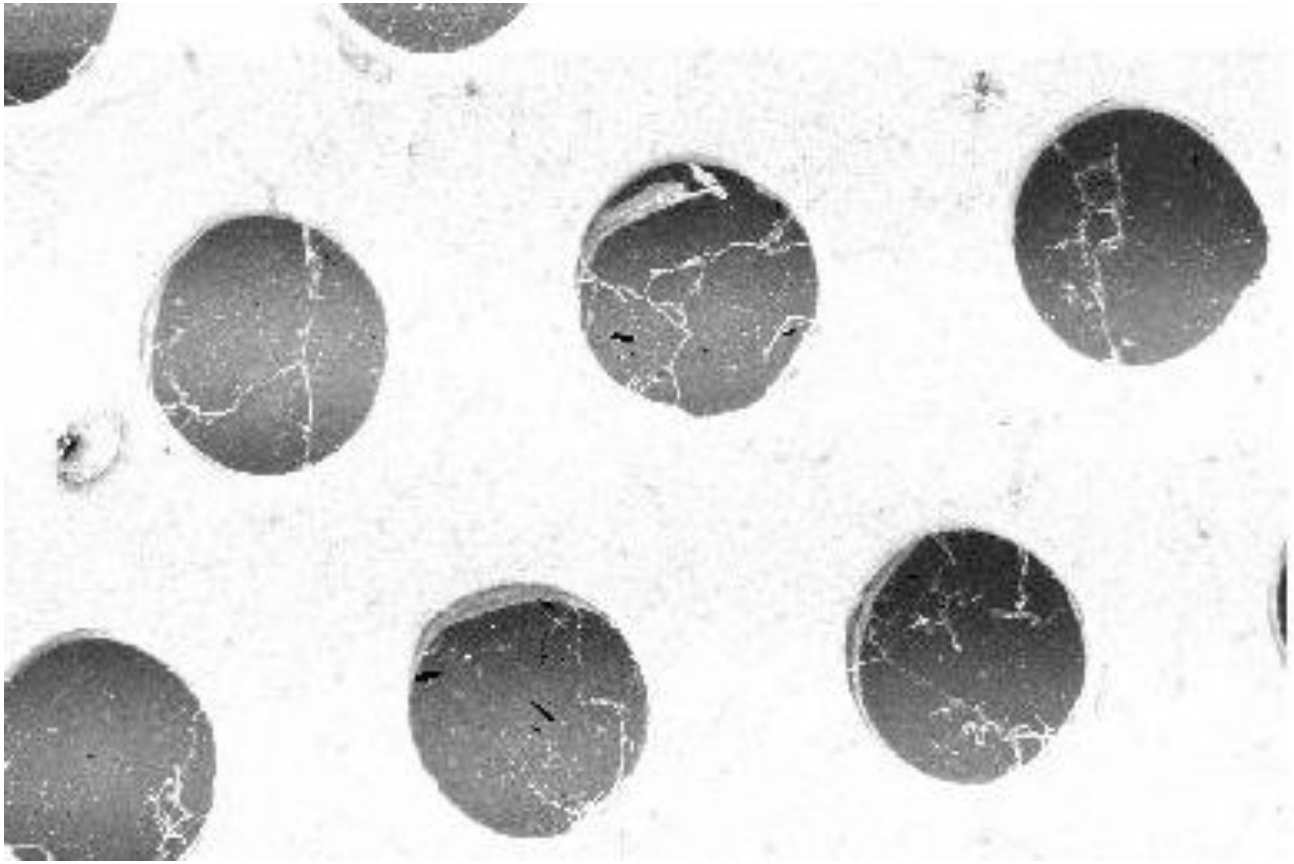






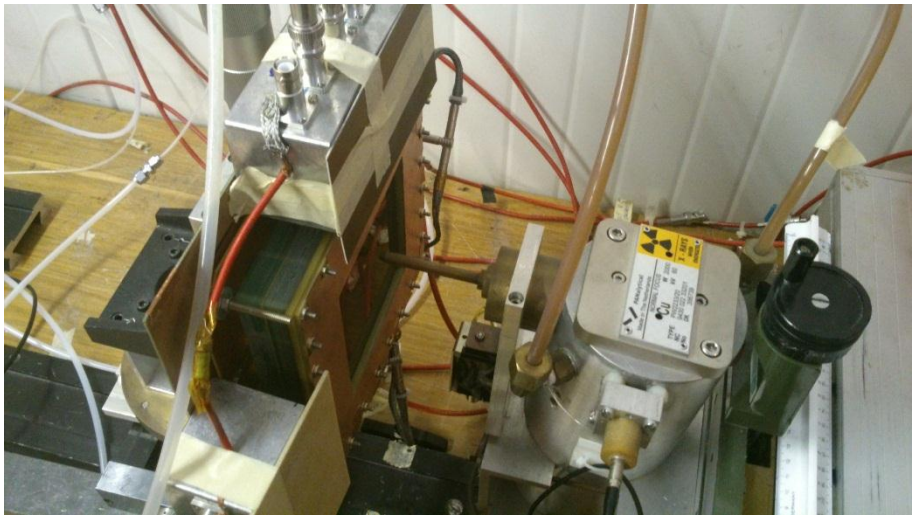


Graphene Transfer



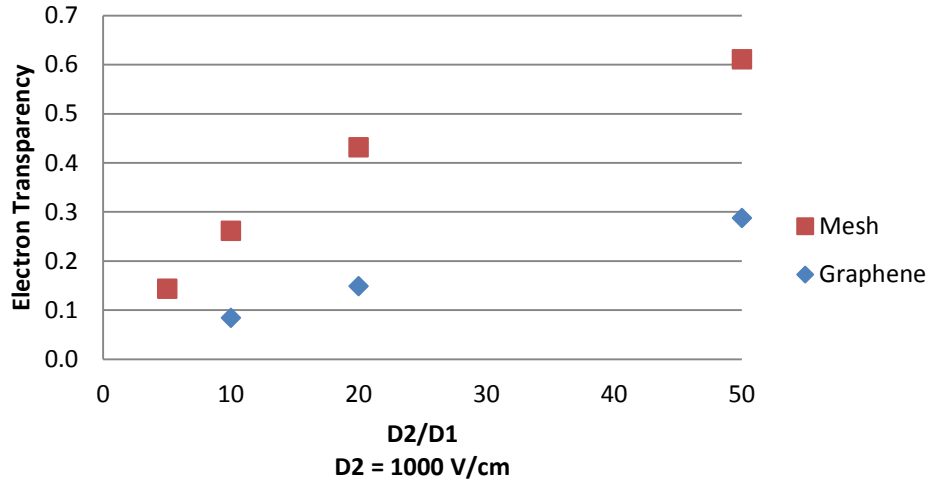
Setup

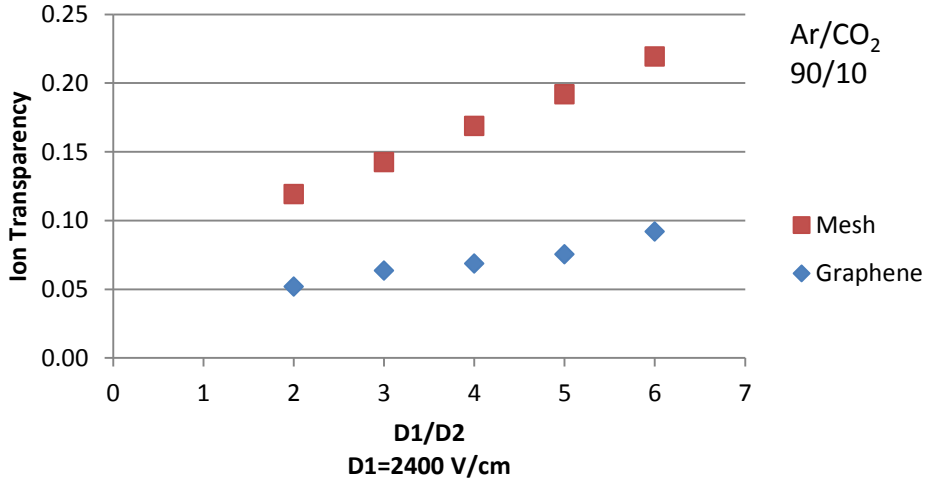
- Ar/CO_2 70/30, 90/10, 93/7
- Detector irradiated with Cu x-ray gun
- Collimated beam ~1 mm² beam size
- Electron transparency 5 kHz, Gain 1.5×10^4
- Ion transparency 2×10^5 Hz, Gain 1.5×10^4



Results

- Lower transparency both for electrons and ions on the covered side
- Layer not opaque for electrons or for ions!





Results

- We assume that charge transfer is due to defects in graphene layer
  - Layer should be opaque to both electrons and ions in the field configurations and gas mixtures used
  - Transparencies increase with higher field ratios: comparable to mesh with smaller hole diameter
  - Transparency higher than optical transparency

Outlook

- Multilayer to verify if charge transfer is due to defects
- Improved transfer technique to achieve undamaged single-layers
- Graphene deposited on GEM to increase energy of electrons in front of layer