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New method for carbon materials nanolithography

Olga Sinitsyna, Georgy Meshkov, Igor Yaminsky

For the first time monolayer graphite (graphene) was isolated in 2004

[K.S. Novoselov et al. Science, 306, 2004,666].

The Nobel Prize in Physics 2010 - Andre Geim, Konstantin Novoselov

It has unique properties:

- breaking strength – 130 GPa [Ch. Lee et al. Science, 321, 2008, 385]
- room temperature mobility - 250 000 cm^2/Vs [M.Orlita et al. PRL, 101, 2008, 267601]

Graphene and graphite films made of several atomic layers are considered perspective for nanoelectronic devices and high sensitive sensor systems development

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Multifunctional scanning probe microscope FemtoScan

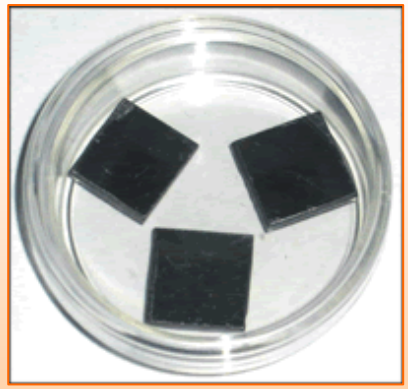
Local Anodic Oxidation (LAO)

Anode: sample surface

Cathode: probe

Electrolyte: water adsorbed on the probe and sample surfaces

Model sample is Highly Oriented Pyrolytic Graphite (HOPG)



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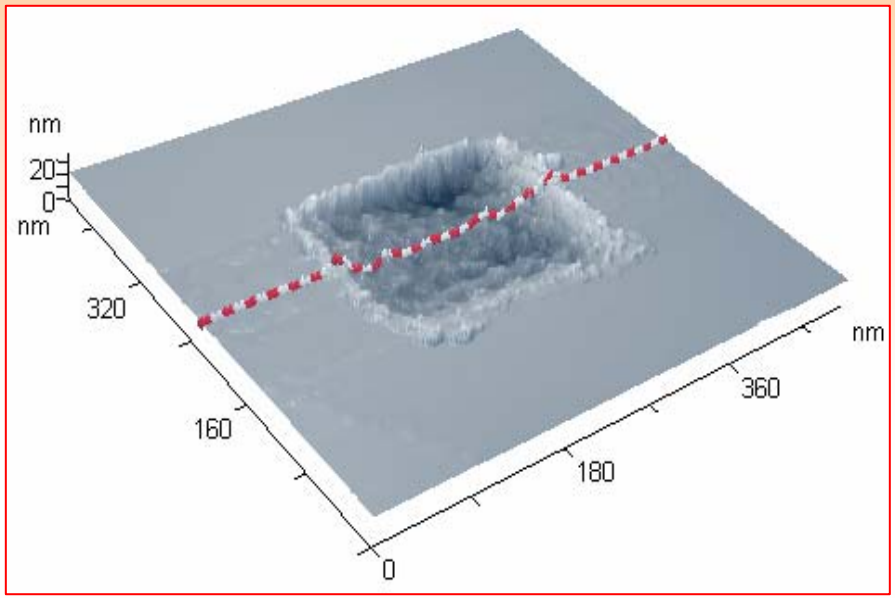
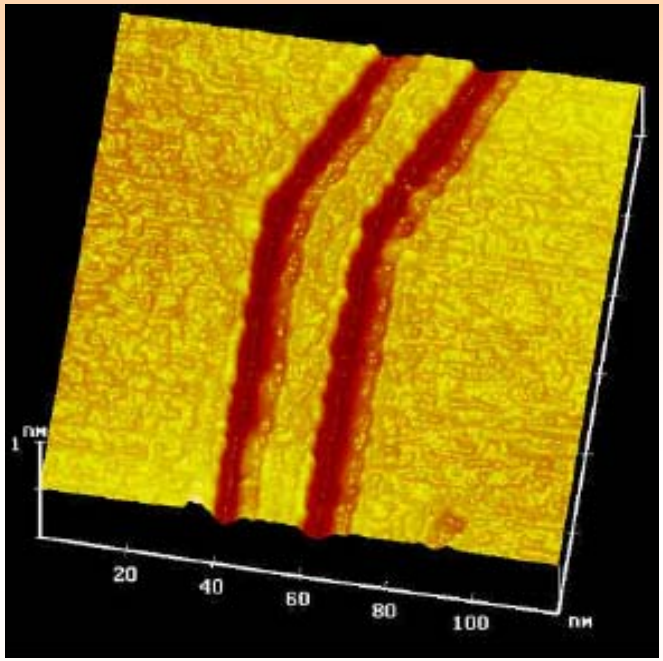
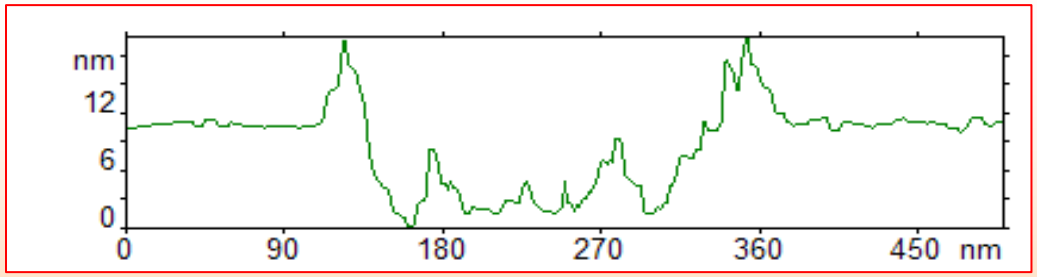
Graphite ⟶ Carbon oxides (CO, CO_2)







arXiv:0806.1662v1
[cond-mat.mes-hall]

Humidity 24%, Pt/Ir probe
Ut = 8.5 В, It = 300 пА, v = 1.5 мкм/с

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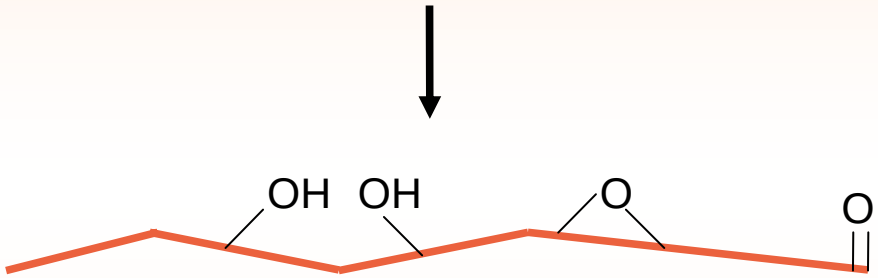
Graphite → **Graphite oxide** → Carbon oxides (CO, CO_2)

Bilayer graphite

D = 3.35 Å



Graphite oxide

D = 6-11 Å

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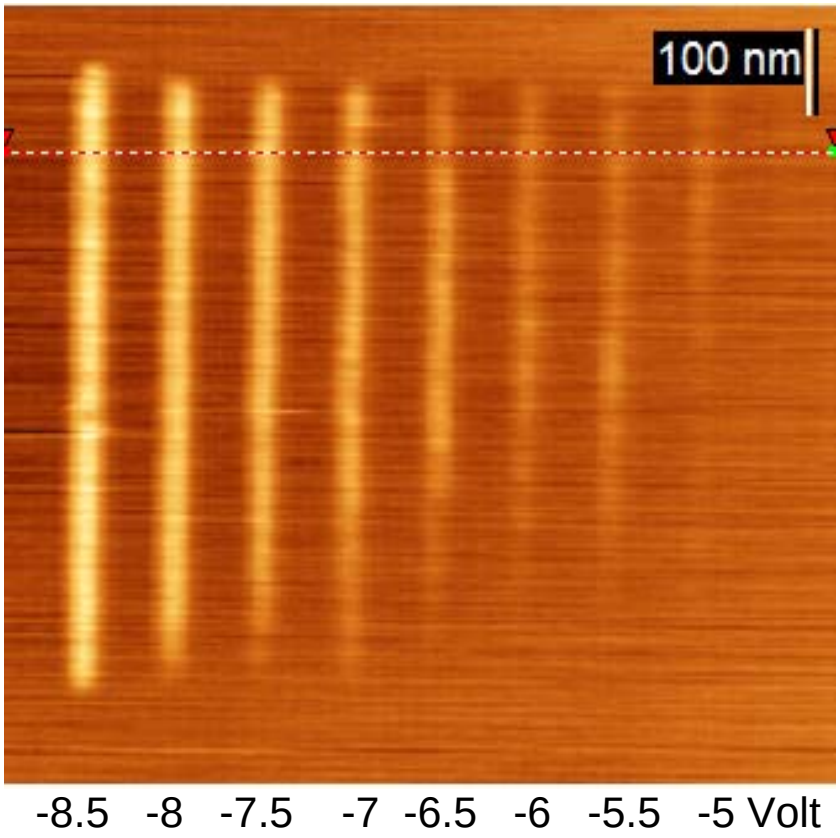
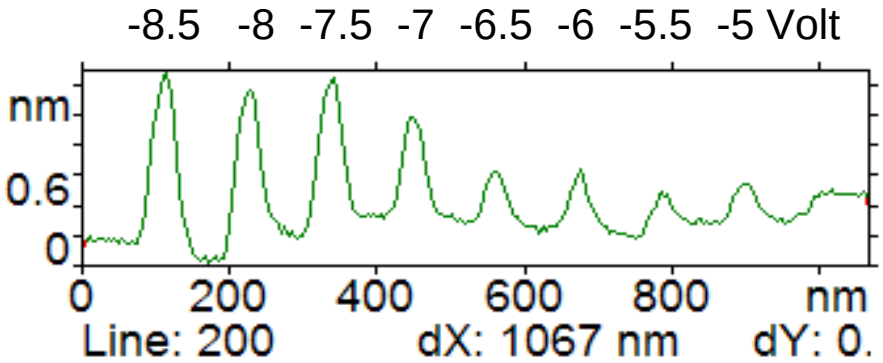
Graphite ⟶ Graphite oxide



The height and length of the lines decreases at low voltage magnitude



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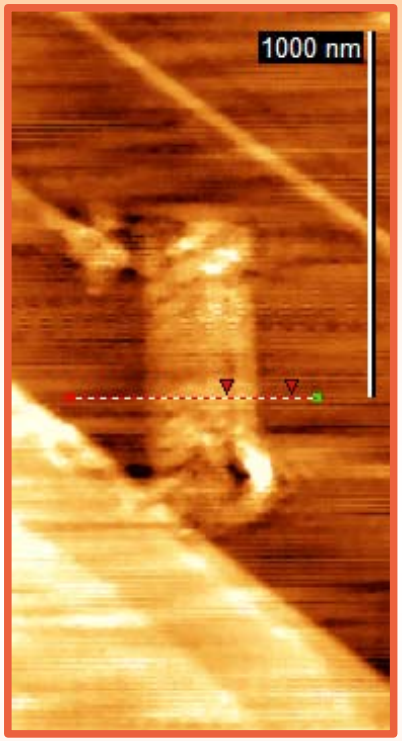
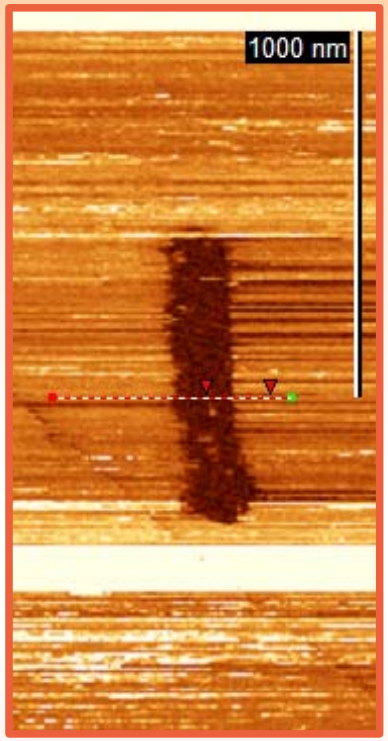
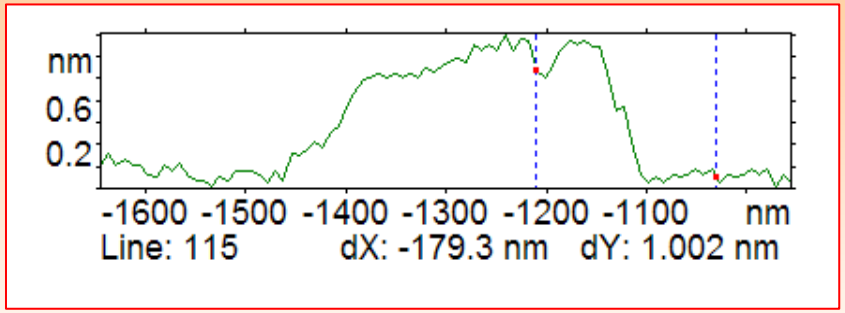
Topography image



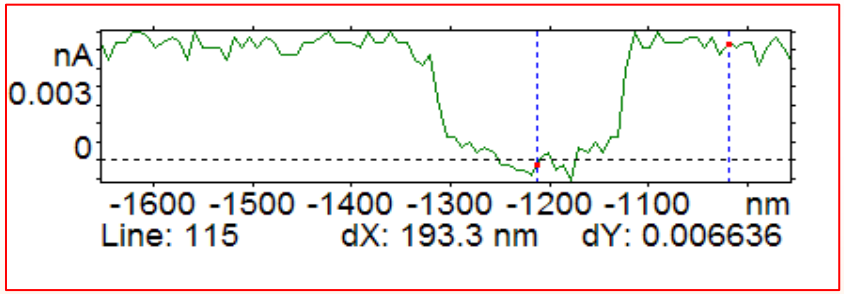
Electrical current image



A cut shown in topography image



A cut shown in electrical current image



The electrical resistivity of contacts:

probe-graphite ~ 1 MOhm

probe-graphite oxide > 10 MOhm

The electrical resistivity of bulk graphite oxide: 10^3-10^7 Ohm·cm [Chung DDL. Journal of Materials Science, 2002, 37, 1475]

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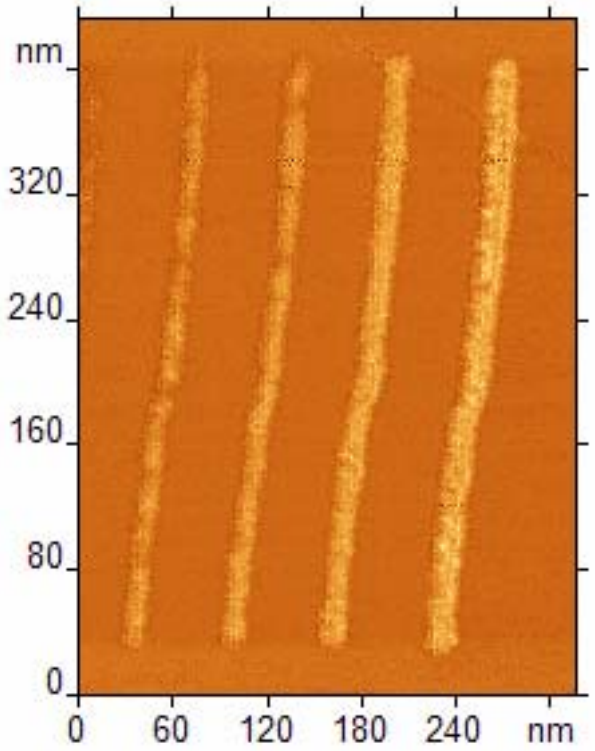
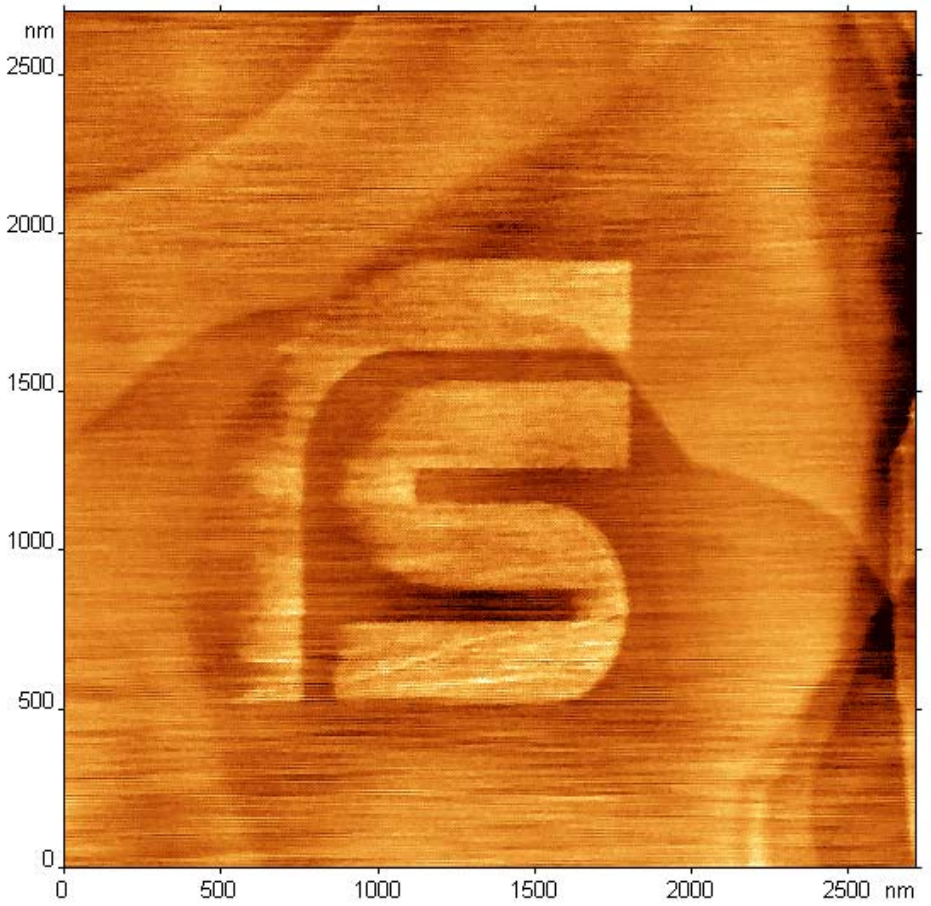


Minimal diameter of line ~ 10 nm

Probe lithography allows us to fabricate structures with any degree of complexity



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Conclusions

- A new method of partial Local Anodic Oxidation of carbon materials was invented
- Graphite oxide is a perspective dielectric material for carbon nanoelectronics

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