



REPUBLIC OF ESTONIA
MINISTRY OF EDUCATION
AND RESEARCH



Estonia's activities in graphene research

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2nd meeting of the FET Flagships Board of Funders (BoF)

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Outline

- **Estonia as ...**
- **University of Tartu**
- **Graphene studies**



Estonia

- Very small country (population *1.3 mln*)
 - With *own language* based *culture* and *HEI system*
 - R&D needs to *balance between specialisation and cultural/educational coverage*
- R&D system
 - Relies on excellence and basic values
 - Funding based on competition (70-80%)
 - *R&D budget ~2% of Government total (0.84% GDP- 2015)*
 - GERD – 1.43% GDP (2014) but 2.31% in 2011

ERAC Peer review: *Steady progress driven by quality, excellence and competition*



Most recent developments

- Wide ranging *renovation of RDI Infrastructures (2007-2015)*
 - From new buildings to research group level equipment
 - 70-80% from equipment (or even more)
- Investments into human resources and mobility

Research environment in Estonia is better than ever, in the sense of up-to-date rooms, apparatuses and human potential



Estonian Research and Development and Innovation Strategy 2014-2020

- Main goal:
 - Good framework conditions for development and making social and economic effects of RDI
- Specific goals:
 - Research excellence and diversity
 - **Increasing the socio-economic impact of R&D**



Graphene studies in Estonia

- Competence:
 - Material sciences:
University of Tartu and Tallinn Technical University
 - **Institute of Physics of the University of Tartu:**
Lab of Thin-Film Technology, Group of Sensor Technologies, other labs in Dpt of Materials Sciences
- Funding from different sources:
 - Institutional and personal grants, Centres of Excellence
 - Topics Broader Material Sciences where graphene study is one of directions
 - Equipment from various sources (multiuser equipment inc)





17 500 students
1700 academic staff

Founded 1632
by Swedish King Gustav Adolf II

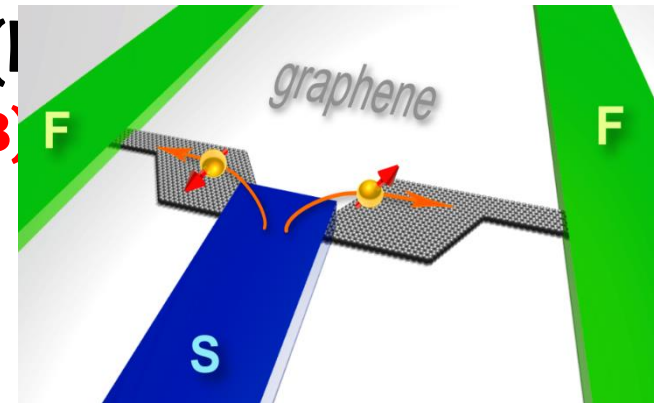


Institute of Physics

New Physicum - 2014

ENTangled Spin pairs in graphene (I)

[Eurocores/EUROGRAPHENE] (2010-2013)



Graphene offers truly unique opportunities for spintronics and for quantum information processing. The two major sources of spin decoherence caused by spin-orbit interaction in combination with electron-phonon coupling and hyperfine interaction with the surrounding nuclei are known to be weak. With the generation of spatially separated entangled pairs of spins in hybrid systems between superconductors and graphene, lots of original possibilities can be envisioned.

http://www.esf.org/fileadmin/Public_documents/Publications/eurographene_scientific_highlights.pdf



RODIN (2010-2013)

Suspended Graphene Nanostructures



The RODIN-project, which seamlessly integrates experimental, industrial and theoretical work, is organized around the concept of suspended single-and few-layer graphene nanostructures and annealed diamond-like carbon films. These structures are ideal for accessing and engineering the intrinsic material properties of graphene. In particular we will focus on engineering and measuring the mechanical and electromechanical properties. This will be done through sculpting of the suspended structures to desired shapes as well as using thermal post-processing methods. Initially, the graphene will be obtained using standard prototype techniques such as exfoliation and plasma assisted chemical vapor deposition. The main goal of the project, one that requires going beyond the current state of the art in multiple areas and has rapid and substantial industrial impact, is the fabrication and demonstration of a tunable graphene resonator with electronic readout. The performance of a mechanical resonator depends sensitively on materials quality, which makes it an ideal test application for a materials-oriented project.





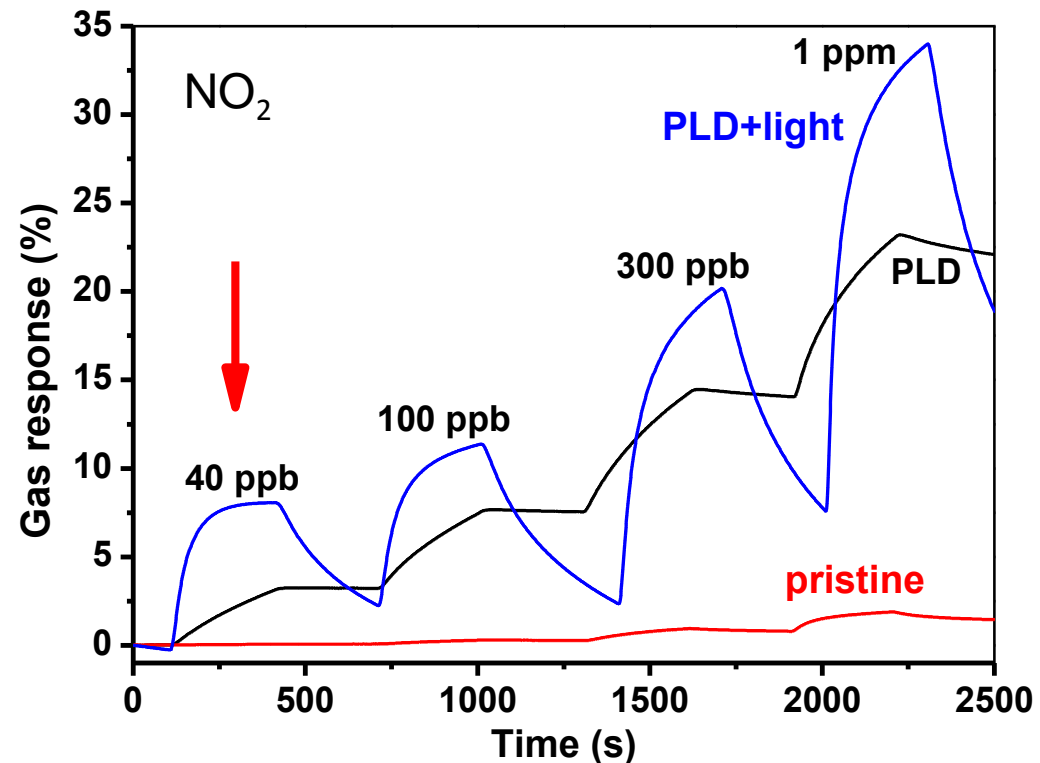
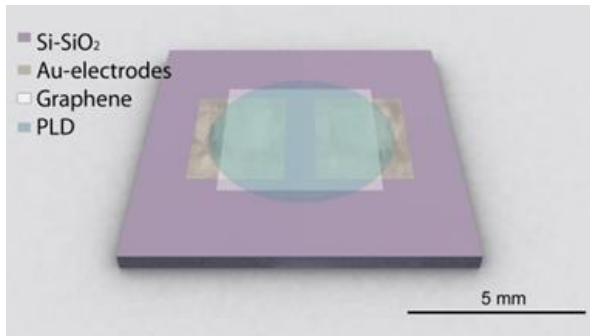
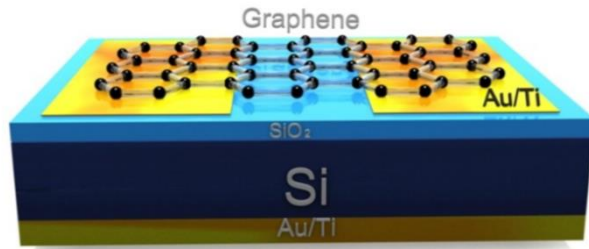
28.01.2013. **PRESS RELEASE** FROM THE GRAPHENE FLAGSHIP: The European Commission has chosen Graphene as one of Europe's first 10-year, 1,000 million euro FET flagships.

**University of Tartu is new partner of the
Graphene Flagship 23.06.2014**

The [Graphene Flagship](#) announced that today one of the largest-ever European research initiatives is doubling in size. 66 new partners are being invited to join the consortium following the results of a €9 million competitive call. University of Tartu Institute of Physics was chosen to be the only partner for the Flagship in Baltic States. Scientists from the University of Tartu are the first from Baltic States to participate in the project cost of one billion euros.

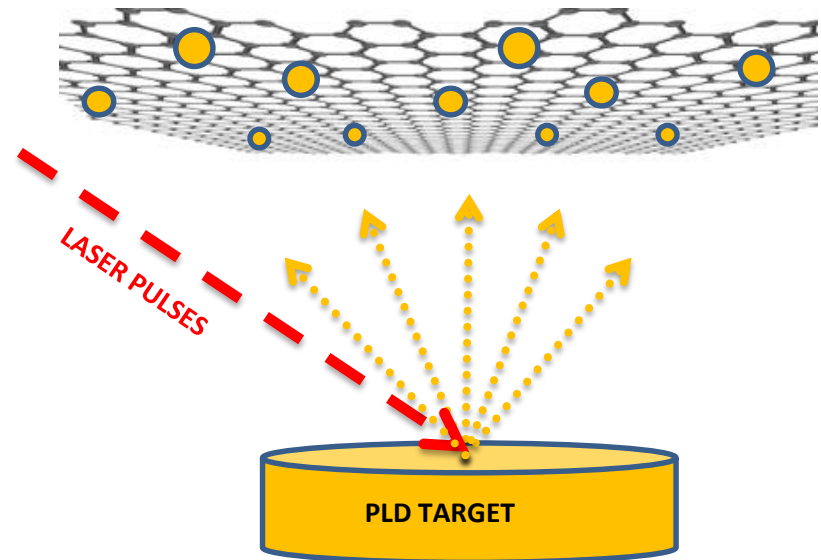
University of Tartu in WP 7(6): Sensors

Task of the University of Tartu [together with Libre Srl (Italy), Dyesol Italia Srl (Italy), Grinp Srl (Italy), nVision Systems & Technologies S.L. (Spain)]: to design, develop, test and validate „on-the-field“ an innovative Prototype of Graphene-Related Node for a Wireless Sensors Network to be used as autonomous system for Environmental Monitorina.



Main achievements (UTARTU)

- **Novel sensibilisation technique – creation of specific adsorption centres by pulsed laser deposition (PLD) on graphene – was proposed and demonstrated for conductometric graphene-based gas sensors**

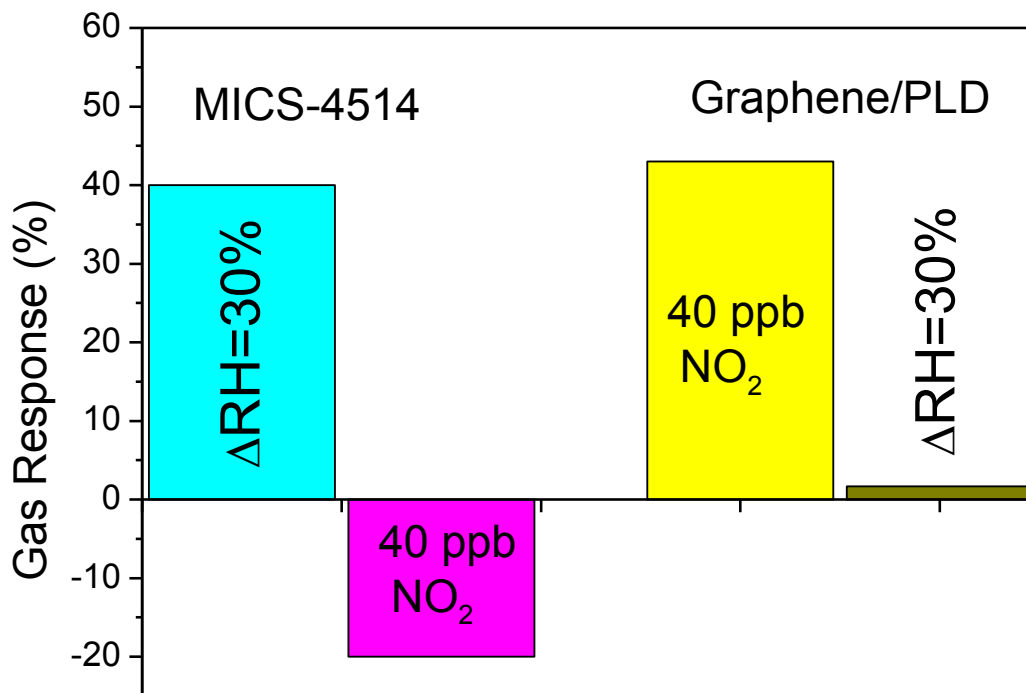


- **Gas sensor prototypes were fabricated for sensor network nodes with optimised PLD-based functionalisation process for NO₂ gas sensing; benchmarking of these prototypes showed low cross-sensitivity to humidity and small drifts as compared to commercial metal-oxide-based sensors**

Comparison with commercial devices



SGX Sensortech



Prototype sensor with sensibilised graphene

- **High sensitivity to NO_2 gas at low concentrations, typical for outdoor air**
- **Low cross-sensitivity to humidity as compared to commercial metal-oxide-based sensors**



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Thank you

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