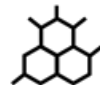


# Low dimensional systems

Presentation by the Head of Department (team leader)  
Assoc. Prof. Martin Kalbac, PhD.

“Retrospective (2015-2019) and Perspective (2019-...)”

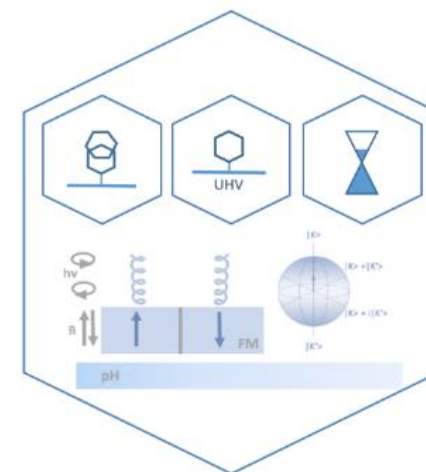


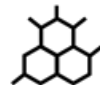
# Focus of the team: mission and areas of interest

**Mission:** Internationally recognized and high quality research in the field of 2-D materials and surfaces.

## Areas of interest:

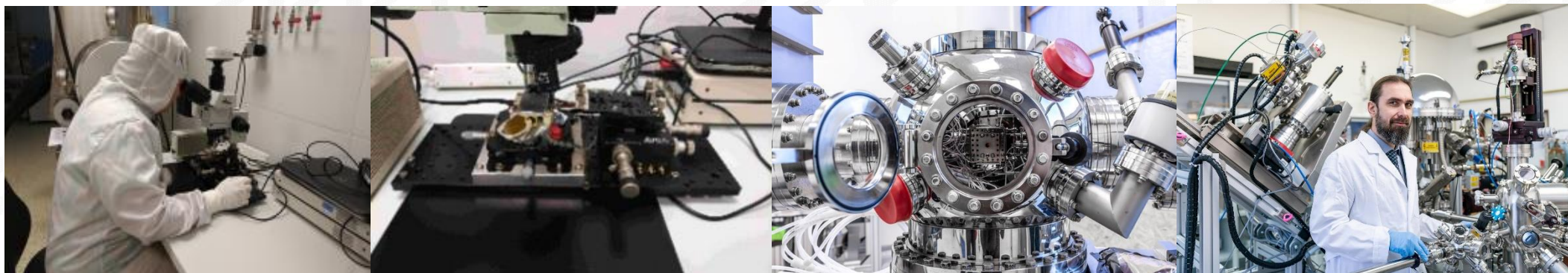
- 2D hybrids - multi-way control of their band structure and reactivity
- Rational catalyst design
- Catalysts designed with atomic precision for heterogeneous reactions





# New and **Key** methods and instruments

- **In situ Raman spectroscopy** (electrochemistry, magnetic field, low temp., pressure)
- XPS/spin resolved ARPES/LEED/STM
- Clean room for optical lithography
- Operando X-ray absorption spectroscopy, **differential electrochemical mass spectroscopy (DEMS)**
- Size-selected cluster deposition equipment (high vacuum), custom catalyst testing equipment (mass-spectrometry, gas-chromatography), synchrotron-based characterization (X-ray absorption, scattering, diffraction).



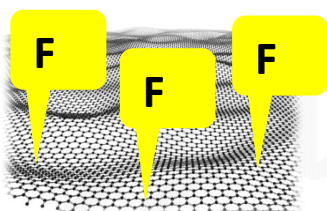
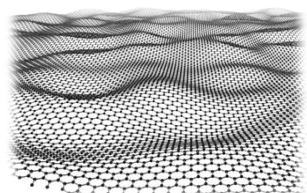


# 1. Tailored functionalization of graphene

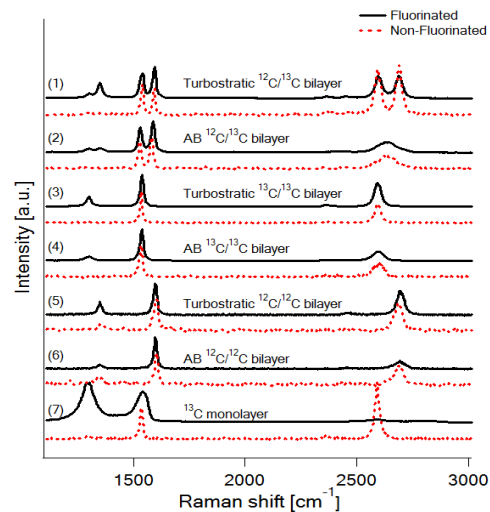
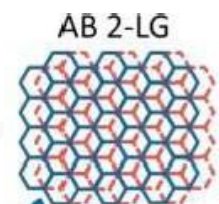
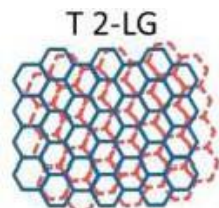


## Understanding the effect

### Choose model

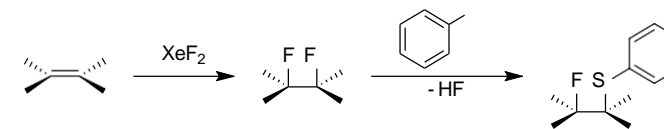


### Reactivity of T and AB stacked bilayers

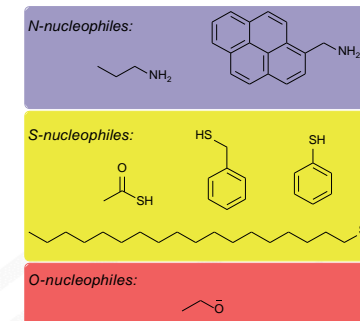


Ek Weis et al. *Chem. Eur. J.*, 21, 1081-1087 (2015).

### Fluorine exchange



### Gas phase



Kováříček et al. *Chem. Eur. J.*, 22, 5404-5408 (2016).  
Kováříček et al. *Carbon*, 118, 200-207 (2017).



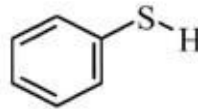
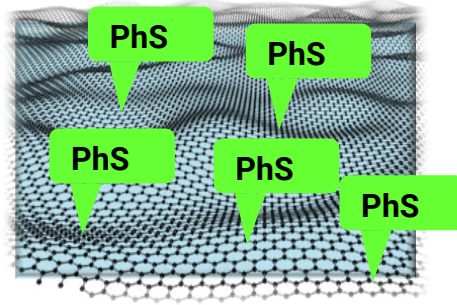
# 1. Tailored functionalization of graphene



Getting feedback- game changer

SERS – old technique – new application  
Fast and conclusive

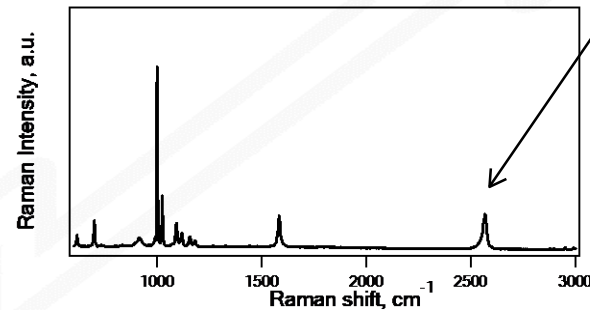
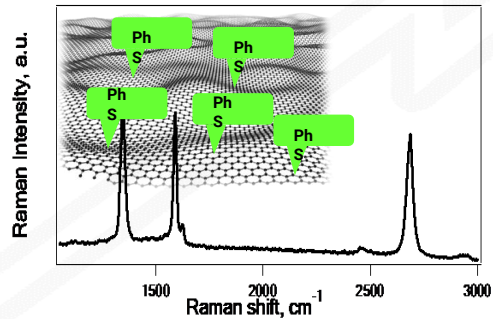
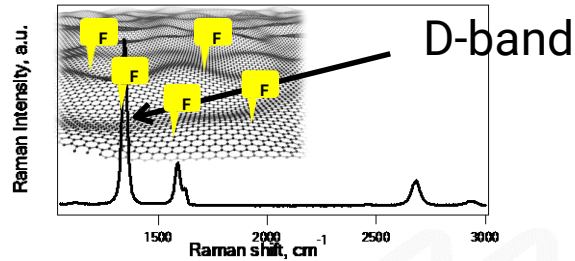
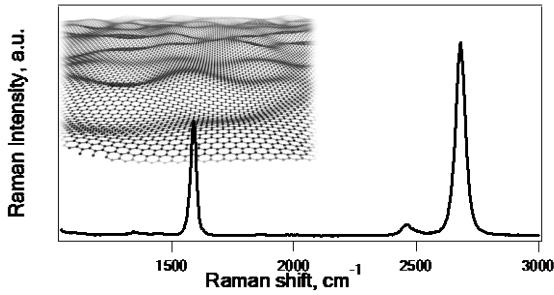
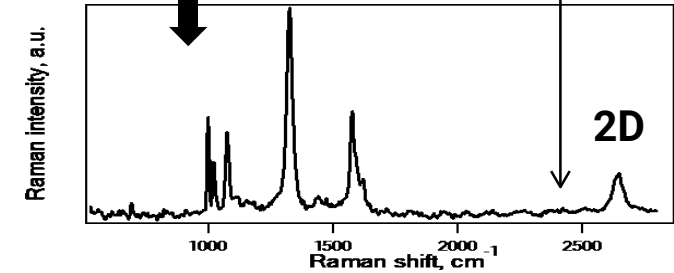
Ag



Thiophenol

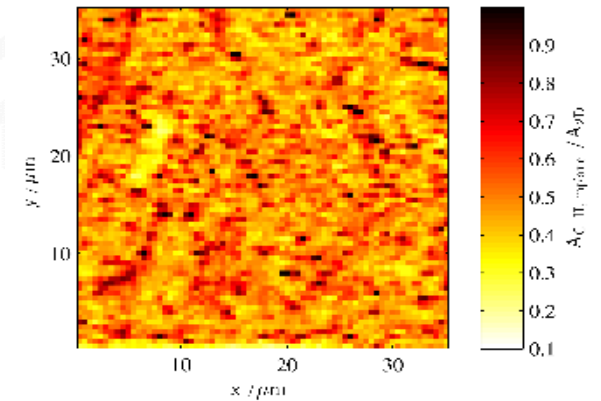
S-H bond vibration

Phenylsulfanyl S-H bond vibration



Kovaříček et al. *Chem. Eur. J.*, 22, 5404-5408 (2016).

Raman mapping

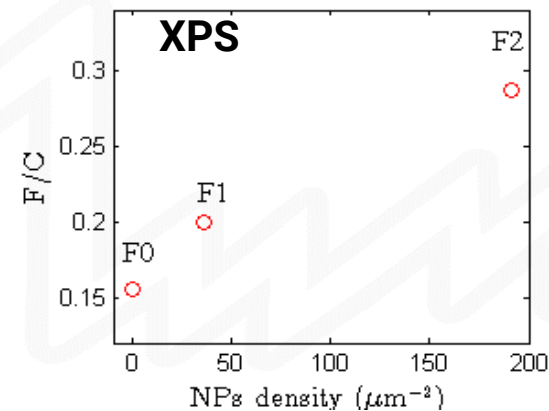
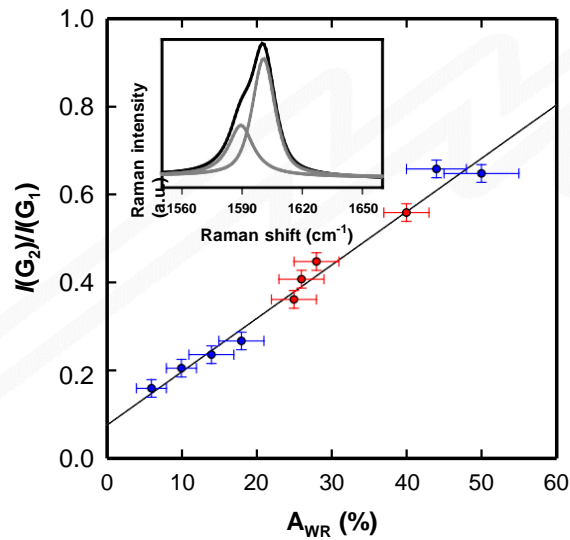
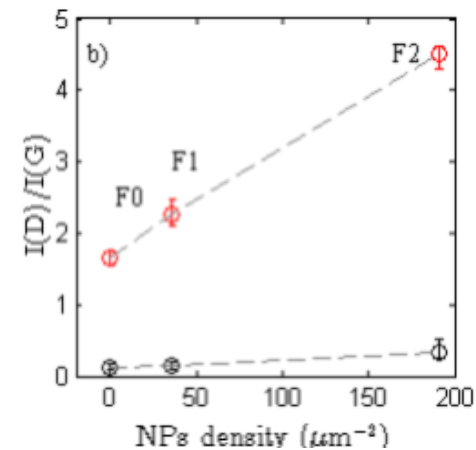
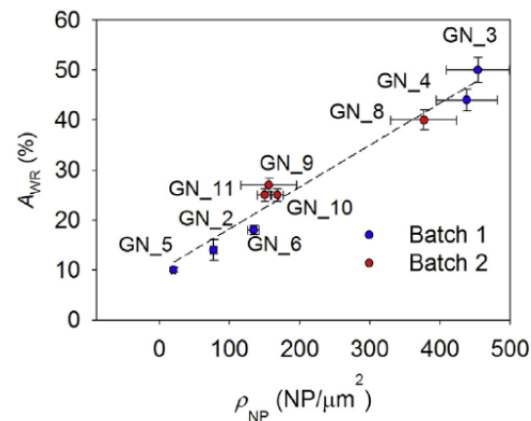
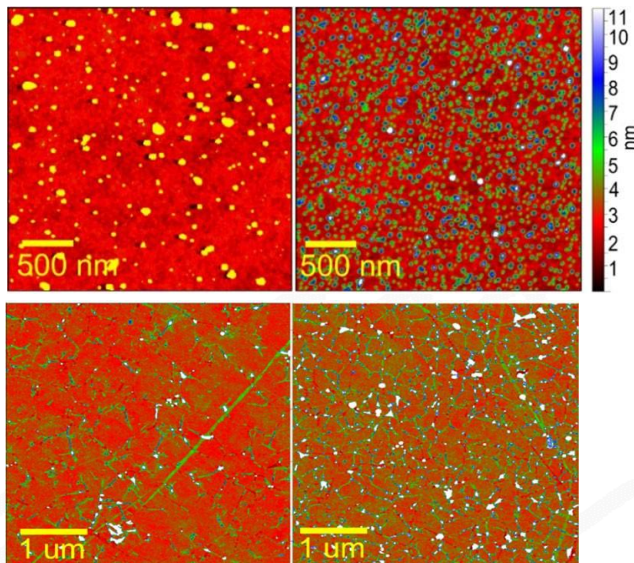
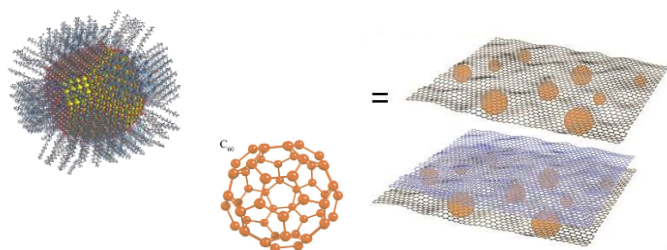




# 1. Tailored functionalization of graphene



Surface - problem or opportunity?



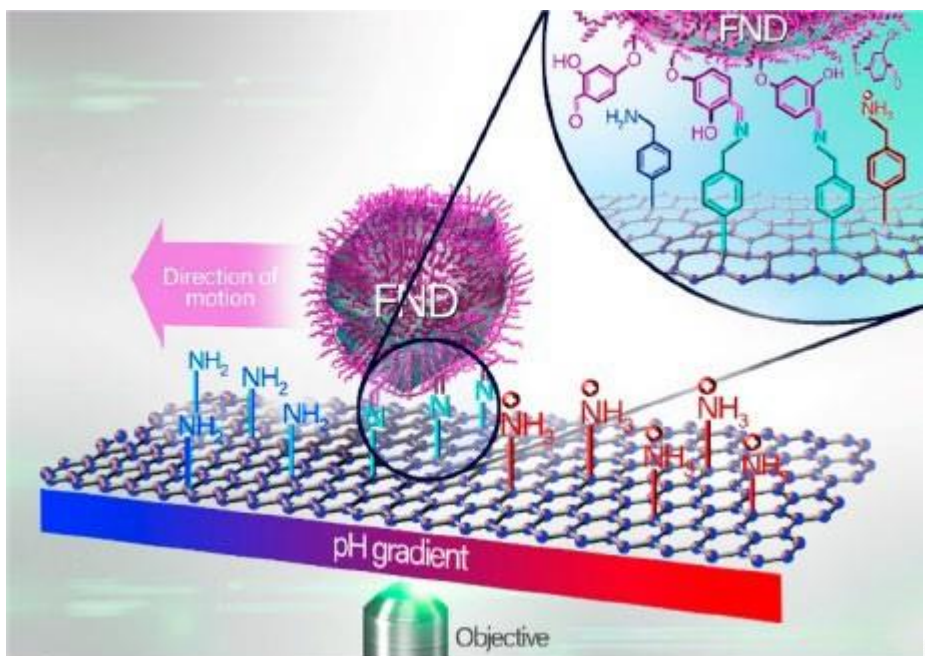
Drogowska et al. *Carbon*, 164, 2007-2014 (2020).



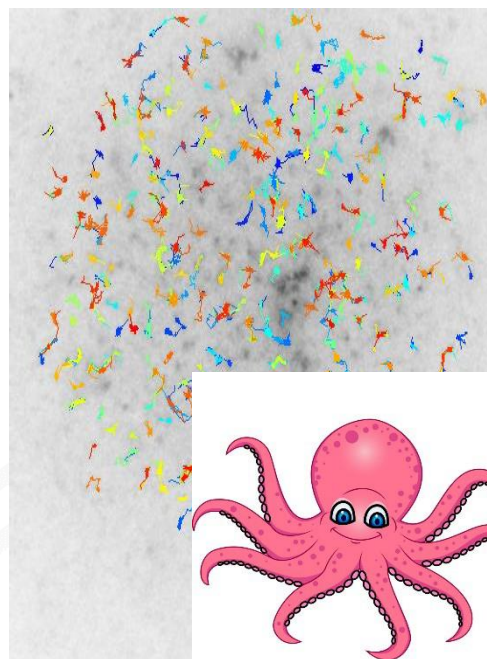
# 1. Tailored functionalization of graphene



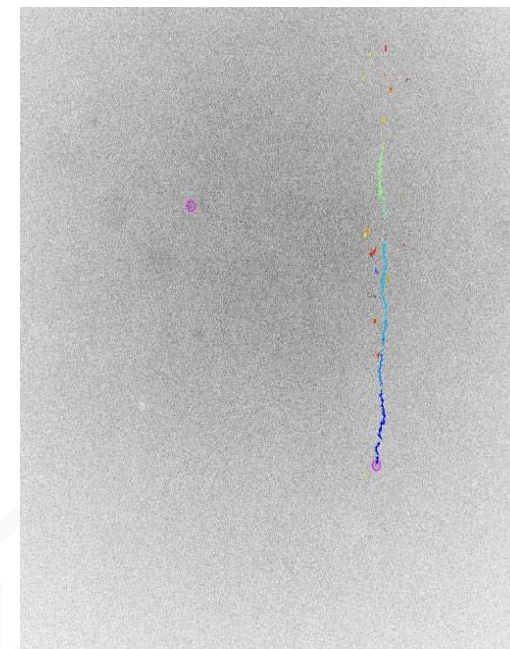
## Application



## Brownian motion in 2-D



## Directional particle motion



Kovaříček et al. ACS Nano, 12, 7141-7147 (2018).



# Grants

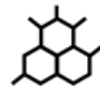
## 24 grants were run by the team members during 2015-2019

- **ERC-CZ:** From Graphene Hybrid Nanostructures to Green Electronics, 2013-2018, MEYS, PI M. Kalbac.
- **ERC-Stg:** Trans-Spin NanoArchitectures: from birth to functionalities in magnetic field, 2017-2020, Co-PI M. Kalbac.
- **NanoenviCZ:** Nanomaterials and Nanotechnologies for Environment Protection and Sustainable Future. 2016-2019, MYES, coordinator M. Kalbac.
- **CARAT:** Carbon allotropes with rationalized nanointerfaces and nano links for environmental and biomedical applications. 2018-2022, MYES,, coordinator M. Kalbac.
- **ERA chair:** ERA Chair at UFCH JH. 2018-2023,H2020-EU, PI J. Hrušák, Co-PI S Vajda.



J. HEYROVSKY CHAIR





# Societal relevance/impact

## Applied projects

- **SEPIOT** – Gas sensors based on hybrid nanostructures for IoT applications. 2019-2022, TACR.
- **CARAT** - Carbon allotropes with rationalized nanointerfaces and nanolinks for environmental and biomedical applications. 2018-2022, MYES.
- **NanoEnviCZ** - Nanomaterials and Nanotechnologies for Environment Protection and Sustainable Future. 2016-2019, MYES.
- **Energy-X** – Transformative chemistry for a sustainable energy future. 2019-2020, EC.
- **TAGGET** - Research, development and characterization of a tunable graphene light emitting hybrid MOEMS device. 2021-2024, EC/TACR.

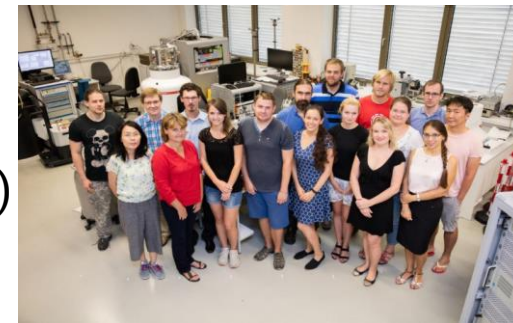
# Collaborations

## Important national partnerships

- **CARAT**, 2018-2022: (2 departments, 2 industrial, 4 academic), coordinator: M. Kalbac
- **NanoEnviCZ**, 2016-2019: (2 departments, 5 academic), coordinator: M. Kalbac
- **Nanocarbon group**, 2013+: instruments, projects, students (1 department, 1 academic)

## International projects

- **MSC -ITN**, 2013-2015, (7 academic, 1 industrial), PI: M. Kalbac
- **MSC -ITN**, 2018-2021, (4 academic, 2 industrial), coordinator: P. Krtil
- **COST Action**, 2018-2020, PI: M. Kalbac
- **MEYS**, 2019-2021, (bilateral – University of Vienna), PI: V. Vales
- **MEYS Inter-excellence**, 2020-2022, (bilateral – MIT, Cambridge), PI: M. Kalbac
- **FET proactive (ONEM)**, 2021-2024, (1 department, 2 academic), PI: T. Juffmann, Wien.
- **ERA-NET**, 2021-2024, (3 academic), PI: M. Kalbac



Nanocarbon group