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REGIONAL CENTRE OF ADVANCED TECHNOLOGIES AND MATERIALS LECTURES

Tuesday, November 22, 1:00 pm
Seminar room of RCPTM (room No. 314), Šlechtitelů 27, Olomouc

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Graphene-based electronic sensors

Graphene's two dimensional nature, highly sensitive unique electrical properties and low intrinsic noise characteristics make it a prime candidate for the creation of a new generation of molecular electronic sensors. The long standing target of molecular electronic sensors is to achieve single-molecule sensitivity and the ability of selective determination of the detected molecules. Although graphene electronic sensors have been demonstrated to be extremely sensitive in vacuum, their sensitivity in air or liquids is still very far off from the desired single-molecule sensitivity. The limited selectivity to different molecules also remains a major problem for their practical use.

Here we present our recent experiments using graphene field-effect transistors (GFETs) to detect different physisorbed molecules on their surface via conductance changes as a function of gate voltage. We demonstrate that bare GFETs have a potential to measure distinct, coverage dependent, conductance signatures upon adsorption of small organic molecules in vacuum [1,2]. This method allowed electronic discrimination of individual DNA nucleobases on GFETs [1], providing a first step towards label-free graphene based electronic DNA sequencing. We compare DNA detection on GFETs in vacuum, air and liquids and present various strategies for label-free electrical detection of DNA molecules, as well using controlled chemical functionalization, to attain high sensitivity and selectivity. To get a deeper insight into the origin of the sensing mechanism and molecular recognition in GFET measurements we also performed ab initio electronic structure calculations using density functional theory (DFT) [3]. The molecular recognition mechanism was found to be closely linked with specific noncovalent molecular interactions with graphene. These effects open up a range of new opportunities for molecular recognition and enhancement of molecular sensitivity of graphene-based electronic sensors.