

“Metrology of molecular interactions using electromagnetically actuated MEMS force sensors – MetMolMEMS” – description for the general public

As ancient atomists tried to divide the world into the smaller and even smaller building blocks, nowadays scientists try to gain better knowledge about the nature by performing analysis of smaller components. For the chemist the smallest objects creating the world are molecules. And the ways they bond decide what chemical compound they create. It's becoming crucial to understand these processes, meaning asking the question “what is the force of their interaction”. The knowledge of what interaction occurs is not enough. More precise description with full understanding comes if the description of phenomena is made with the numbers – the quantitative description. The goal of the MetMolMEMS project is to make a measurement – give the value of the forces acting between particular molecules.

For the force measurements in the macroscopic world we use a forcemeter, typically in the form of a spring. The spring's stretching is the indication of the change of the acting force. The microscopic version of a spring could be a vibrating microcantilever. Analysis of its vibrations can be used as a means to describe interactions between a molecule hanging at the end and a molecule lying on the sample of interest. A microcantilever is the tool which enables scientists not only to observe but also to measure the phenomena of the nanoworld.

But even the tool is attracting attention. Its development and handling is not so easy. With the next steps, the MetMolMEMS group envisions the necessity of design and fabrication of a new kind of microcantilevers. The roadmap includes also the development of a measurement environment and definition of handling procedures. The important goal of the group is to create some kind of multitool, which will allow investigation of multiple interactions at the same time (the idea is to apply both a single, an array of two, and an array of four cantilevers with each cantilever being independently controlled). For this it will be needed to apply technologically advanced solutions related with inducing vibrations – the actuators (in the form of integrated electromagnetic actuators which will make use of the force acting on a conductor in a magnetic field).

In metrology scientific interest lies in the area of measurements which require that results are related to traceable standards and norms. But there is an issue that in nanometrology the standards are still under development. This inspired the group to perform calibration of the deflection of proposed tools by the different force – the interaction caused by the momentum of photons falling onto the cantilever (the light pressure).

The measurement setup itself even if applied to investigations of small changes will be further developed. It will contain, among others, optical devices, optoelectronics, electronics and mechanics. The investigated interactions will be the Van der Waals and ion interactions.

In the project the group will prepare, except measurement systems, the nanotools – elastic microcantilevers and substrates on which selected molecules will be placed. The solution for molecule deposition will be developed by the MetMolMEMS group: Nanometrology Division of the Faculty of Microsystem Electronics and Photonics, Wrocław University of Technology and our partners: Institute of Electron Technology (Warsaw), Adam Mickiewicz University (Poznań) and Poznań University of Technology.