ENIGMA: dEciphering Nanochemistry by usInG cheMical modification of cArbon nanotubes for modern medicine

The unexpected beginning of the year 2020 gave us all a proof that the value of health cannot be overestimated, and so we need appropriate means of its protection. Besides the pandemic, many civilization diseases take a high death toll every year in the background. The most notable cause of death in the modern world can be grouped under the term cardiovascular diseases. They account for more than half of deaths annually. In 2017, the death toll due to these conditions reached 17.8M people. Bad eating habits and an unhealthy lifestyle are likely to increase this share in the future. We need materials, which could enable detection of early signs of these diseases to literally save lives.

The discovery of nanotechnology has brought to the world a plethora of materials of unique structure and properties. A particular role on this front play carbon nanotubes, which are tiny cylindrical objects with diameters 10 000x smaller than a human hair. Among many special attributes, they exhibit photoluminescence *i.e.* they emit light upon appropriate excitation. Unfortunately, the emitted light is quite dim because of the inherent limitations of the material. It has been recently observed that the brightness can be increased up 20x when a slight amount of functional groups is attached to the carbon nanotubes. Nevertheless, the current tools utilized for this purpose are tedious and do not exploit the full potential of the material.

In this project, a spectrum of novel techniques of chemical modification of carbon nanotubes will be established. They will be quick, fully controllable, and versatile, which will enable grafting of the carbon nanotube surface on demand. Most importantly, since the nature of the attached functional group directly determines the optical properties of the material, it will be possible to tune the nature of emitted light from them with more ease. This will lead to a library of carbon nanotubes of diverse optical characteristics, which will be used to create an optical system for the detection of abnormalities in lipid management. Such conditions give the first signs that one is likely to suffer from a cardiovascular disease soon. The aim of the project is to develop an optical sensing platform based on modified carbon nanotubes for detection of these diseases at a sufficiently early stage to increase the survival rates of patients.