C1. **Description for the general public**

Optoelectronics is a branch of technical sciences dealing with transformations between electricity and electromagnetic radiation. What fruits did the development of this field yield?

In recent years, two groups of its applications have gained particular attention:

- photovoltaic cells – devices generating electricity from the sun radiation reaching them.
- electroluminescent diodes (LED) – devices transforming electricity into light, replacing widely used light bulbs and fluorescent lamps, as well as liquid crystal displays, due to their higher energetic efficiency.

Initially, optoelectronics was based only on silicone semiconductors, which are costly to fabricate and process into devices. An alternative to these materials has, however, been found – organic semiconductors, which are less expensive and allow flexible devices to be produced – photovoltaic cells and displays, which can be bent without damaging them.

Organic optoelectronics based on organic semiconductors, has at first struggled with the issue of lower performance than what was achieved for silicone semiconductors. With the most recent developments, this problem has been resolved and at least comparable operating parameters are being reported. What brought about this success?

It was made possible by the development of new, durable materials, with ever better parameters such as conductivity of negative charges (electrons) and positive charges (holes), the ability to emit light of a given colour or to capture and transform the light into electricity. **The aim of this project is to take the next step – to develop new, multifunctional pi-conjugate materials, fulfilling the requirements of current organic optoelectronics.** What path should be taken to achieve this goal?

Because the properties of organic semiconductors are tied to their chemical structure, the basis of their development is the design of molecules – oligomers and polymers. Currently, such systems are designed using smaller molecules – monomers. Different combinations of monomers can give rise to a wide array of potential material properties. It is, also possible to combine known oligomers and polymers into larger structures, however, such design requires expertise in studying a wide range of oligomers and polymers. Utilising the know-how gathered by our team, we designed, synthesised and investigated the first batch of such electroactive copolymers. The primary building block of their structure was a polysiloxane chain, onto which we attached a number of poly(3-hexylthiophene) chains, conducting holes when an external electric field is applied, and a number of poly(ethylene glycol) chains, fulfilling a supporting function. Improved results were obtained for these copolymers, in regards to the standalone polymers comprising them, validating this approach. Consequently, we decided to broaden the scope of our research to include other organic hole and electron conducting systems, as well as different supporting polymer chains. **We intend to use advanced organic synthesis techniques as a bridge, allowing us to apply our knowledge of designing organic semiconductors to develop new, high-performance materials for optoelectronics.**

What benefits are there to be had from developing such materials and potentially applying them? The spread of renewable energy sources already allows us to shift away from energetics based on the limited amounts of fossil fuels, thereby allowing us to curb the rate of their depletion. Developing light sources and displays, which transform electricity into light ever more efficiently, serves the same goal, by limiting our consumption of electricity. **That is why we undertook this project – to advance organic optoelectronics by broadening our knowledge and creating new materials, which will serve to support the development of the economics of the Polish and global energy sector.**