

The main purpose of this project is to synthesize high-performance, water-soluble single-component free radical photoinitiators showing absorption characteristics in the visible range, enabling them to be tailored to produce three-dimensional micro-fabricated hydrogel structures as an extracellular matrix for 3D bioprinting.

Due to the constant search for effective initiating systems which will be characterized by the highest possible solubility in water, as well as a good energetic compatibility with modern, pro-environmental light sources, such as Vis-LEDs, a research plan has been proposed to develop, study and test new free-radical photoinitiators. The most important research issues to be addressed in the proposed project include:

- **The issue of adjusting the light absorption characteristics of radical photoinitiators to the emission characteristics of the light sources in the visible range**, which is extremely important in the development of biomedical applications, where the biological material can only be exposed to visible light, due to their special sensitivity to damaging UV radiation. So far used photoinitiators of radical polymerization show very poor compatibility with visible light sources, which causes that most of the light energy is wasted instead of being consumed for the photopolymerization process.
- **The issue of solubility of radical photoinitiators in a polar aqueous environment**. So far, several compounds have been used as water-soluble free-radical photoinitiators, with their solubility being relatively low and unsatisfactory.
- **The issue of the lack of biological safety of free-radical photoinitiators**. Currently, an important factor limiting the use of chemical compounds as radical initiators for biomedical applications is not only their poor water solubility, but above all their toxicity. Moreover, for many commercially available initiators, information on their toxicity is limited due to the lack of data on the basic safety assessment of *in vitro* models. In practice, the problem of photoinitiators' toxicity causes not only the lack of application possibilities in *in vitro* models, but also inhibits the development of new materials. Additionally, biological data on the mechanism of initiators and their photolysis products penetration into cells and their influence on basic physiological cell processes are limited. Therefore, the project also includes research on safety assessment of newly developed radical photoinitiators.
- **The issue of increasing the quantum efficiency of generating radicals at the photoinitiation stage and the development of highly effective initiating structures with relatively long life times in the excited state**. So far, a number of basic studies on the influence of structural factors on the quantum yield of photolysis of single-component radical photoinitiators have been conducted. These studies, however, have not led to the development of highly efficient radical photoinitiators in the visible range. Therefore, many aspects need to be studied in detail, as these are important issues for the effectiveness of designing new photoinitiators. Moreover, it is planned to investigate the possibilities of increasing the quantum efficiency of photoinitiators with the help of amine initiators built into the structure, by developing and analysing the mechanism of operation of such designed systems.

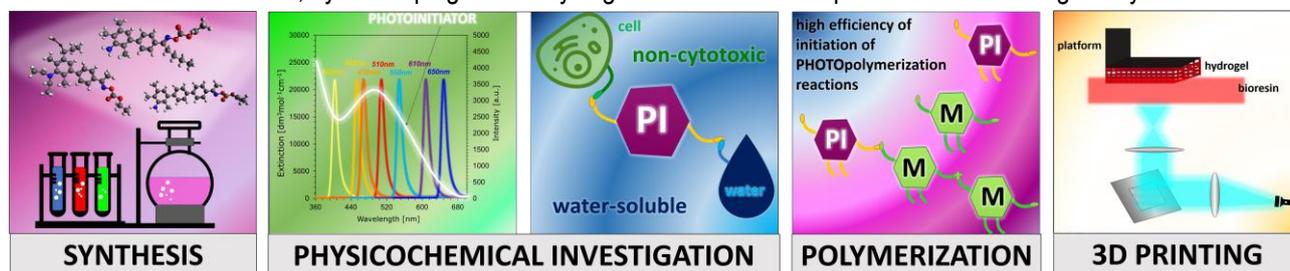


Figure 1. Main stages of project implementation.

Primary research aimed at the experimental clarification of the above issues will not only contribute to a better understanding of the mechanisms of initiation of free-radical photoinitiators, but will also provide guidelines for the design of new, water-soluble, effective, visible initiators for free-radical polymerization. Thus, the development of new, Polish radical photoinitiators for free-radical photopolymerization of materials for biomedical applications and the knowledge of the properties of these compounds, their influence on the polymerization kinetics as well as the mechanism of action should significantly accelerate technological progress in this field.

The proposed project was designed to fill a research gap for water-soluble radical initiators that would effectively initiate visible light photopolymerization processes and, in addition, would not exhibit toxicity. The new photoinitiators would be effectively used to obtain microfabricated hydrogel structures as an extracellular matrix for 3D bioprinting.