Nowadays, it is becoming increasingly important in industry to design and operate processes in an environmentally friendly manner. This is no different in the case of polymer material manufacturing. This stimulates a great interest in methods based on photochemically initiated processes. Such materials are obtained using light without the need for high temperatures, which reduces the energy required for the process. Photopolymerization is also carried out without the use of solvents, which is in line with the leading trends in green chemistry.

Currently, photopolymerization processes are one of the most efficient methods for obtaining polymeric materials and, in addition, it is still a rapidly developing field. The most commonly used method of polymerization using light is radical photopolymerization. The process of radical photopolymerization is based on obtaining a product as a result of combining single monomer molecules into long chains. To achieve this it is necessary to introduce photoinitiators into the system. These are chemical compounds which under the influence of ultraviolet (UV) or visible (Vis) light are decomposed to form active centers (radicals). The photoinitiator is an element that not only initiates the whole process, but also determines the necessary conditions and process parameters. It is particularly important to irradiate the entire composition with light of the length corresponding to the absorption spectrum of the initiator used, so that it can undergo photodissociation to form reactive radicals.

Initially, the photopolymerization process was carried out using UV light and was used primarily in the coatings industry. Today, however, this process is also gaining importance in other industries, e.g. in photolithography, medicine, microelectronics, and the fastest development of this technology is in 3D printing. Unfortunately, these industries severely limit the possibilities of using photoinitiators operating in the UV range. This is due to the harmfulness of this radiation to humans, or in the case of 3D printing, the inability to achieve adequate depth of cure. On the other hand, currently there are not many initiators available which would work efficiently under visible light. The most efficient are compounds based on phosphine oxides, which, according to recent literature reports, are defined as highly toxic compounds. Reports indicate that these compounds must be withdrawn from numerous applications by the end of 2022. These facts indicate a need to search for new, innovative solutions.

Therefore, the topic of the planned work in this project is the preparation of highly efficient single-component radical photoinitiators showing activity in the visible light range. The idea of the synthesis of new initiators is based on the extension of the conjugated system of known and successfully applied solutions used in the UV range – benzil ketals, which will provide them with high photopolymerization initiation efficiency. The extension of the conjugation system will allow for a bathochromic shift of the spectrum, so that the initiators will operate under the influence of LEDs with maximum emission in visible light. In case the assumed absorption spectrum is not reached, further modifications will be planned by introduction of functional groups, which will shift the spectrum even more. The obtained initiators are new compounds, not previously reported in the literature.

The new initiators will be characterized spectroscopically. For each initiator, an absorption spectrum will be determined, the molar absorption coefficient will be calculated and a photolysis test will be performed to check the ability of the proposed systems to photodissociate under visible light. The photopolymerization kinetics and conversion rates will be determined by FT-IR technique, while additional DSC, photoreological and electrochemical measurements will provide a more detailed understanding of the polymerization process using the proposed systems. The next step will be carried out for the compounds showing the best properties and will consist in testing their cytotoxicity. The final stage of the research will be to test the best photoinitiators for their possible application use - in the case of 3D printing.

An additional benefit of the work presented in this project will be to expand the current knowledge of photopolymerization processes and the systems involved in these processes.