The use of classical drug delivery methods causes numerous problems and limitations related to low drug activity at the target location or negative effects on healthy areas of the body. To address these challenges, scientists have been developing drug carriers in the form of nanoparticles or nanocapsules, which have revolutionised the approach to pharmaceutical therapy. However, the increasing demand for more precise and controllable drug delivery systems has made the use of drug nanocarriers itself no longer sufficient, for example, for the delivery of immunosuppressive drugs. In addition, a number of additional requirements such as precise control of the drug release profile in the body, improved delivery of hydrophobic drugs, targeted drug delivery or prolonged drug release causes a constant search for new solutions that meet the listed requirements.

Considering the possibilities offered by the combination of nanotechnology and modern additive technologies, providing increasingly precise solutions enabling high personalisation of pharmacological treatment, a research plan has been proposed, allowing the synthesis and modification of polyelectrolyte drug nanocarriers, their implementation in photosensitive resins for 3D-VAT printing, and consequently manufacturing drug-on-chip materials with defined geometry, allowing controlled release of active substances. Therefore, the main aim of the project is to **develop methods for manufacturing next-generation, three-dimensional "drug-on-chip" materials with controlled release of active substances, dedicated to personalised medicine.**

The implementation of this objective consists of 5 research tasks:

TASK 1: Synthesis of polyelectrolyte drug nanocarriers;
TASK 2: Determination of basic parameters of the obtained polyelectrolyte nanocapsules;
TASK 3: Development of photosensitive nano-resin for 3D printing containing polyelectrolyte nanocarriers;
TASK 4: 3D printing of hydrogel materials with defined geometries containing polyelectrolyte drug nanocapsules using light-based printing technology;
TASK 5: Analysis of the properties of the obtained drug-on-chip materials.

The proposed research project is a response to an identified research gap that is the lack of solutions to obtain hydrogel materials containing polymer nanocarriers in the form of polyelectrolyte nanocapsules using the 3D-VAT printing technique. The project has an interdisciplinary character and will undoubtedly influence the development of disciplines, such as materials engineering, chemistry, nanotechnology, and certain medical aspects. Moreover, the implementation of the proposed research will contribute to the theoretical and experimental basis for broadening the knowledge of polyelectrolyte drug nanocarriers, 3D printing processes, and modern drug-on-chip materials. The expected results include the development of methods for obtaining a new generation of drug-on-chip materials, along with the analysis of the processes occurring during their manufacture, such as the analysis of the effect of the addition of drug-containing nanocapsules on the printing process, the control of the spatial distribution of the capsules, or the determination of the principle of operation of these modern materials, along with the determination of the drug release profile and the study of its biological activity. Consequently, the fulfilment of the stated goals will provide a good foundation for further application research, which may contribute to the development of new therapies.