Polymers (macromolecules) are chemical compounds, composed of many repeating subunits, which can be compared to chains of corals (Fig. 1). Our body is made of natural polymers such as nucleic acids and proteins, while synthetic polymers accompany us in our daily lives. They are used in the manufacture of packaging, clothing, electronics and even vaccines against COVID-19.

The properties of polymers can be modified both during and after their synthesis. In both cases, by controlling the structure and chemical composition, it is possible to tailor the properties of polymers for specific applications. Conventional polymerization methods, such as radical polymerization, result in materials with a broad molecular weight distribution. This means that such a polymer contains molecules of very different lengths, which can adversely affect the properties. The development of *reversible-deactivation radical polymerization* (RDRP) has revolutionized polymer synthesis. RDRP methods allow to precise control of the architecture, composition, and length of the polymer chain. The resulting materials are characterized by a narrow molecular weight distribution and a variety of structures, such as linear chains, brushes, combs, rings, stars, or networks. This is important because a properly designed polymer composition and its micro- and macrostructure give it the desired physicochemical properties. This makes it possible to create polymers that expand or contract under certain stimuli, such as temperature or light, that self-assemble into more complex structures, or that self-heal. Such polymers are in high demand and are used to make advanced materials with unique properties.

Reversible-radical polymerization with deactivation (RDRP) is a class of polymerization techniques that use reversible reactions to control the chain growth of radical polymerization. Unlike traditional radical polymerization, which produces a broad distribution of chain lengths, RDRP allows for the precise synthesis of polymers with narrow molecular weight distributions and complex architectures.

In recent years, significant progress has been made in the field of photoinduced RDRP (photo-RDRP) techniques. Photo-RDRP methods allow the synthesis of polymers using light as an external stimulus to initiate polymerization (Fig. 1). One of the major advantages of photo-RDRP techniques is the ability to synthesize polymers under mild conditions. However, a key challenge currently facing scientists is that most photo-RDRP methods developed to date require high-energy ultraviolet (UV) or blue light. Therefore, photo-RDRP techniques that could use low-energy light, particularly in the red and near-infrared (NIR) range, are being investigated. Far-red and NIR light penetrates organic materials, including biological tissues, better than UV light and is less absorbed by proteins and nucleic acids. The use of NIR opens up new possibilities in the synthesis of functional and advanced biomaterials. Unfortunately, so far, only a few RDRP methods have been developed to enable the synthesis of polymers under such low-energy light irradiation.

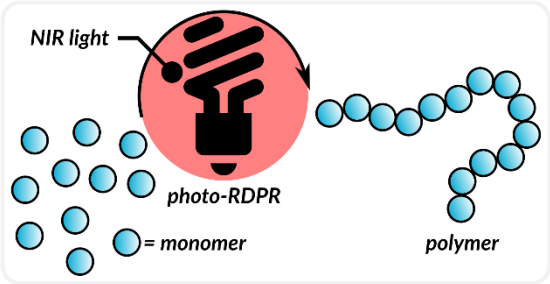

***Fig. 1**. Use of photo-RDPR in polymer synthesis*

The goal of this project is to use red and near-infrared light to initiate and control radical polymerization with reversible deactivation (Fig. 1). The newly developed photo-RDRP techniques may be of great importance for the development of medicine. In the future, this technology may be used to synthesize advanced polymer materials, such as nucleic acid (DNA/RNA)-synthetic polymer hybrids. Such materials may be used in the synthesis of new drugs, vaccines, in the development of new gene therapies, or in other medical applications.