"Ionizing radiation, rate constants and mechanisms of radical reactions in the development of dressings used in treatment of difficult to heal wounds."

How to link together so distant issues such as the determination of the rate constant rate and mechanisms of induced by ionizing radiation radical reactions and the treatment of chronic wounds? Well, this is not a simple matter, but unquestionably it is worthwhile to undertake this scientific research.

Hard-to-heal wounds is a global problem touching more and more patients due to the increasing incidence of obesity and type II diabetes, but also associated with the continuous aging of human population. According to statistics of the World Health Organization (2015) until 400 million people worldwide suffer from diabetes. Polish Diabetes Association reports that in Poland it is up to 2.7 million patients and more than 220,000 are affected by chronic diabetic wounds. The treatment of wounds caused by complications of the diabetic foot and decubitus ulcers as well as regular burn wounds requires dressings that not only protect the wound from external microbiological factors, but will actively support the process of tissue regeneration. Novel wound dressings can made of synthetic and natural polymers are commonly used in chronic wound healing. Natural polymers are known for excellent biocompatibility and biodegradability. It is worth noting that many of them are also able to support and intensify the biological processes - bioactive dressings, they constitute so-called third generation of dressings. Dextran - a natural polymer of bacterial origin - possesses all above mentioned properties. Physicochemical properties of dextran, bioresorbability and angiogenic character makes it a highly attractive material for use in soft tissues regeneration. The chemical modifications of dextran can be achieved and synthesized derivatives can be used to obtain dextran-based hydrogels that possess advantageous functions of the parent polysaccharide.

The first step of the project will be the synthesis of dextran derivative (Dex-MA – dextran methacrylate) having substituents capable of chemical crosslinking and to develop conditions suitable for the formation of macroscopic and nano/micro-hydrogels with use of clean techniques, i.e. without use of other chemical additives. The main aim of the project is to investigate the degradation or/and crosslinking processes of dextran methacrylate (Dex-MA) in its aqueous solutions initiated by ionizing radiation towards formation of macroscopic or nano- and micro-hydrogels. It is well known that under appropriate conditions of radiation processing, crosslinking (intra- and intermolecular) reactions in some polymers may lead to the formation of nano-/microscopic or macroscopic networks (gels). The use of radiation technology, which is a clean method using no chemicals, for modifying methacrylated dextran derivatives can be especially interesting in the designing of new hydrogel-based wound dressings, because no potential toxicants such as initiators or catalysts are required. However, for natural polymers the effect of crosslinking is not so easy to achieve as with synthetic polymers, due to the contribution of competing degradation processes. Proposed research employs pulse radiolysis technique that will provide controlled formation of radicals and allow for both qualitative and quantitative description of their reactions - the rate constants of reaction of Dex-MA with products of water radiolysis, and the kinetics of macroradical decay will be determined in order to elucidate reactions mechanisms, leading to various end-products. Obtained data will allow to characterize factors affecting the dominant reactions in the water-polymer systems, that is Dex-MA degradation and/or crosslinking. Understanding the mechanisms of reactions leading to degradation and, especially, crosslinking of intra- and intermolecular character, will facilitate effective design and production of biomedical materials using ionizing radiation from modified dextran in future.