New composite biomaterials prepared by photocrosslinking

Advances in the synthesis of new biomaterials based on non-toxic monomers and their composites (containing functional additives as reinforcement) provide a source of new solutions for medical sector. The prime objective of their application is repair of damaged/diseased tissues. Although many materials are currently used in medicine (mainly metals, ceramics or polymers), but numerous solutions present on the market do not meet the expectations of both doctors and patients. An example is Kirshner wires commonly used to stabilize fractured bones, including fractures of the distal epiphysis of the radius bone of the hand. However, in the case of multifracture or crush fractures, this method of stabilization is not always effective and the patient may be exposed to numerous complications (nerve damage, loss of repositioning). Therefore, the use of another material that would fuse bone fragments in seconds and stabilize the fracture *in situ in vivo* is a particularly advantageous feature that can be achieved using photopolymerization. During this process, the composition (usually a liquid containing certain functional additives) is transformed into a solid (composite), which under living conditions becomes both an implant that replenishes the defect and stabilizes the fracture. An important feature of such a solution will be the ability to use a simple method of injecting the material into the defect site.

The need for such materials has become the motivation for designing a pioneering study on the synthesis of new polymeric and composite networks obtained by photopolymerization using UV light (mainly UV-LED). The synthesis of new polymer network precursors will be performed using non-toxic molecules of natural origin (from vegetable oils and cellulose processing) and bioactive ceramics. Detailed knowledge of the molecular structure, including molar masses, will be provided by research performed during the doctoral student's internship at The Ohio State University, OH, USA. The main functional characteristic of the new materials will be viscosity, which determines the injectability of such materials. Importantly, the combination of different precursors with differing properties, i.e., mono- and bicyclic 2,5-furan derivatives with long-chain fatty acids and bioactive phosphate ceramics/bioglass and hydrogel microbeads (e.g. gelatin) will result in the development of new composite materials that will be transformed into solids using photopolymerization. New knowledge will be gained on the kinetics of photocrosslinking, degradation profile and adhesion mechanism to wet substrates (mimicking the environment of living bone tissue). Biofunctionality of the new materials (compressive strength and adhesion) will be evaluated by mechanical and microscopic studies. The photocrosslinking kinetics of the new compounds will be studied using differential scanning photocalorimetry. It will be important to perform the enzymatic (lipase) and hydrolytic degradation studies of materials in simulated body fluid (SBF). The influence of precursors chemical structure, composition and viscosity on the degradation profile of composite materials will be determined. Preliminary studies conducted with furan monomers and lack of their toxicity became the motivation for this project on new composite biomaterials, which, to our knowledge, represent a scientific novelty not yet described in the literature.

This research work is aimed at obtaining new knowledge in the field of basic research and will be an important step towards future applications of new materials as injectable implants for stabilizing fractures of the distal epiphysis of the radius bone of the hand or other multifracture/crush fractures.