Streszczenie po angielsku

Vision is a multi-stage process that starts in the eye. The eye, which is a physical imaging system, is also a complex set of numerous biological structures. If the work of at least one of the structures is disturbed, then the visual function is impaired significantly. An important element of the eye imaging system is the eye lens. To properly perform its function, the lens must be transparent. The situation in which the lens loses its translucency and contributes to amblyopia is referred to in medicine as a cataract. This disease is an enormous social and economic problem today, because every visually impaired person needs special and often expensive care. It is worrying that every year the number of cataracts increases. This increase is mainly related to the aging population, because the cataract mainly affects the elderly. However, more and more often this disease occurs in young people and children. Despite the huge scale of the problem, the only way to cure cataract surgery is to remove the optic lens and replace it with an artificial intraocular lens. Unfortunately, some of the treatments require reimplantation. The most common cause of artificial intraocular lens replacement is poor vision. Lenses after implantation into the eye are exposed to agents that induce numerous aging processes. The main aim of the thesis is to analyze the changes caused by the aging process in optical and mechanical properties of artificial intraocular lenses. The purpose of the work was realized through experimental research and numerical simulations.

The scope of experimental research presented in this thesis includes:

• Development of a controlled long-term aging process for implants at a stable temperature, in a solution simulating aqueous humor;

• Development of recording techniques for appearing defects and quantitative analysis of their density;

• Development of an IOL surface measurement technique that evaluates the shape change caused by the lack of hydrolytic stability of the implant and its effect on the change in optical power;

• Measurement of IOL surface roughness and influence of aging processes on values of parameters determining it;

• Development and preparation of a measuring bench to measure the compression force of the haptic part of the IOL and the influence of the aging processes on their elasticity (the property that determines the stability of an implant in the lenticular pouch).

The scope of numerical research includes:

• Modeling changes in the most common material defects: Development of a model of an artificial implantable lens implanted with defects based on the results of experimental research and literature reports;
• Modeling changes in the most common material defects:
o glistening,
o calcium deposits,
• Modeling material changes:
o changes in surface roughness;
• Analysis of the impact of the modeled changes on retinal image quality.

Prolonged implant exposure in aggressive environments within the eyeball causes changes that have a direct or indirect effect on the optical properties of the implant. The changes in the mechanical properties of the lens indirectly affect the change in optical properties. The rigidity of the haptic parts responsible for the stability of the location of the implant changes and the stresses in the optical part of the lens change. Changes caused by aging processes that directly affect the degradation of retinal image quality are changes in the shape of the lens surface and the appearance of defects in materials such as glistening and calcium deposits.

The research has made it possible to understand the processes that occur in artificial intraocular lenses. They may also provide guidance in developing new materials.

The results obtained may be helpful in anticipating situations where lenses are exchanged urgently for patients with significant deterioration in imaging quality. The scope of this thesis requires taking many elements in the field of biomedical engineering, optics and mechanics into account.