

Abstract of the dissertation: *Multifocal refractive-diffractive intraocular lenses with high-depth diffractive surface relief*

Purpose

An important part of cataract surgery is the implantation of an intraocular lens (IOL). The purpose of this research was to design a hybrid diffractive-refractive multifocal IOL, which would provide patients with a sharp vision within possibly large area of the object space and to evaluate imaging properties of the proposed IOL.

Methods

In the thesis the Fresnel approximation of scalar diffraction theory of light and the Fourier optics approach is used to describe formation of retinal images of an axial point object and to calculate axial and lateral visual point spread functions (VPSFs) of the multifocal hybrid IOL. Numerical calculations are performed using a commercial software package MATLAB (The MathWorks Inc.). To calculate distances of sharp vision the back propagation of the vergence method and the Gullstrand-Emsley schematic eye, implanted with a hybrid IOL fixed at 5.75 mm from the corneal vertex is used.

Results

It has been proved that the diffraction profiles used so far in multifocal intraocular lenses can produce multifocality of at most the third order. Thus, after taking into account the depth of field of the human eye, they ensure a sharp vision of only three separate regions of this space. It has been shown that the use of symmetrical phase diffraction profiles of particular phase modulation amplitude values, greater than 5.79 rad, allows to remove this restriction. Two new diffraction profiles are proposed: the symmetrized parabolic profile and the full cycle sinusoidal profile. The thesis is focused on the analysis of hybrid lenses, whose sinusoidal diffraction profile assures appearance of the seven diffraction orders (foci) of similar diffraction efficiency. For heptafocal lenses axial and lateral visual point spread functions were computed. It was also shown that for a minimum depth of field of the human eye these lenses assure a sharp vision at any distance greater than 30 cm.

The dissertation is a contribution to the research on diffraction and imaging properties of multifocal diffractive and hybrid lenses and provides new theoretical tools for the design and optimisation of such lenses.