PROFILE CHARACTERIZATION METHODS OF CONTACT LENS SURFACE WITH THE USE OF THE ATOMIC FORCE MICROSCOPY AND OPTICAL CONFOCAL MICROSCOPY

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ABSTRACT

In the dissertation, the problem of measurement and characterization of surface topography of soft contact lenses using atomic force microscopy (AFM) and confocal microscopy was studied. The main goals of the work were: to analyze statistical parameters of popular contact lenses and to develop a uniform procedure for measuring contact lens surface using AFM.

In the main experiment surface topography of seven silicone-hydrogel lenses was measured. A hypothesis was confirmed that material type and surface treatment process influence the surface topography. It was proved that new generation lenses exhibit smaller roughness that older ones.

The impact of the type of AFM probe on surface topography measurements was also investigated. As a result of modification of the probe surface using trimethoxy(propyl)silane, the ability to visualize the surface topography of the material has been achieved, which, due to the strong attraction of the probe to the surface was not possible in the tapping mode with standard silicone probe.

An important aspect analyzed in the dissertation was to understand the process of accumulation of deposits on the lens surface during wear. In the work the surface topography of both new and used lenses were investigated to analyze changes that occur during daily use. In the experiment the lens surfaces were compared for two regimes of care: continuous operation and lenses subjected to daily care. The lenses used in the continuous regime exhibited higher roughness in comparison with the new lenses. This result is not obvious since for certain lens types lower roughness is achieved during use because of deposits that fill gaps in the surface. The measurement of lenses subjected to the daily procedure of cleaning resulted in lower surface roughness when compared with lenses in the continuous regime of operation. In the case of both care procedures the roughness was still higher than in the case of new lenses. Changes in the surface topography of one-day contact lens that result from the wear were also investigated. Similarly to monthly lenses for one-day lenses the surface topography changes were observed but at the same time were smaller than for monthly lenses due to shorter time of operation.

The possibility of characterization of the surface topography of contact lenses using confocal microscopy was also investigated. The use of this type of microscope is cheaper and less invasive than of AFM, and potentially allows to inspect changes during the daily use. The images were analyzed that are distributions of maximum optical response. The obtained results show that there is a relationship between the surface roughness of the lenses and the optical response, however, it is not possible to use the commonly used global statistical parameters to evaluate and compare the surface roughness of the lenses.

An attempt was made to develop a parameter related to the surface roughness of contact lenses using the optical response obtained with a confocal microscope. However, preliminary analysis showed that despite the visual differences between the images, the global statistical parameters used in the analysis of the AFM images are not applicable to the analysis of confocal microscopic images.

Additionally, granulometric analysis of the confocal microscope images was performed, which gave an inconclusive result, suggesting that the index related to surface roughness should be developed using more advanced local image analysis methods or other numerical tools.