VIDEO ARTICLE

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Advanced Surface Modification of Ophthalmic Lenses for Visual Problems Correction

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Graphical abstract

Fig. 1(a) shows the experimental results comparing mono-focal lens with extended depth of focus (EDOF) lens. Fig. 1(b) shows clinical trials results for presbyopia subjects where the visual acuity of EDOF lens is compared with regular mono-focal lens that was used to perform far vision correction. One can see that the EDOF lens gives good performance (close to zero in LogMAR units) both for near as well as for far vision while mono-focal lens provides good far vision correction but does not give sharp near vision (0.5 in log MAR units). Fig. 1(c) shows a wearable contact lens (CL) with the EDOF pattern. Fig. 1(d) presents the reduced halo effect that the EDOF surface treatment can provide on RGP CL when imaging of a point source. The EDOF performs similarly to a mono-focal lens while aspheric RGP lens (used for presbyopia) has very strong halo. Fig. 1(e) shows results of large-scale clinical trials where PVMF-HA (commercial bifocal CL) is compared with the EDOF CL that gives about 3 times better performance. Fig. 1(f) shows soft EDOF CL treated to obtained fixed optical performance being invariant to tears.

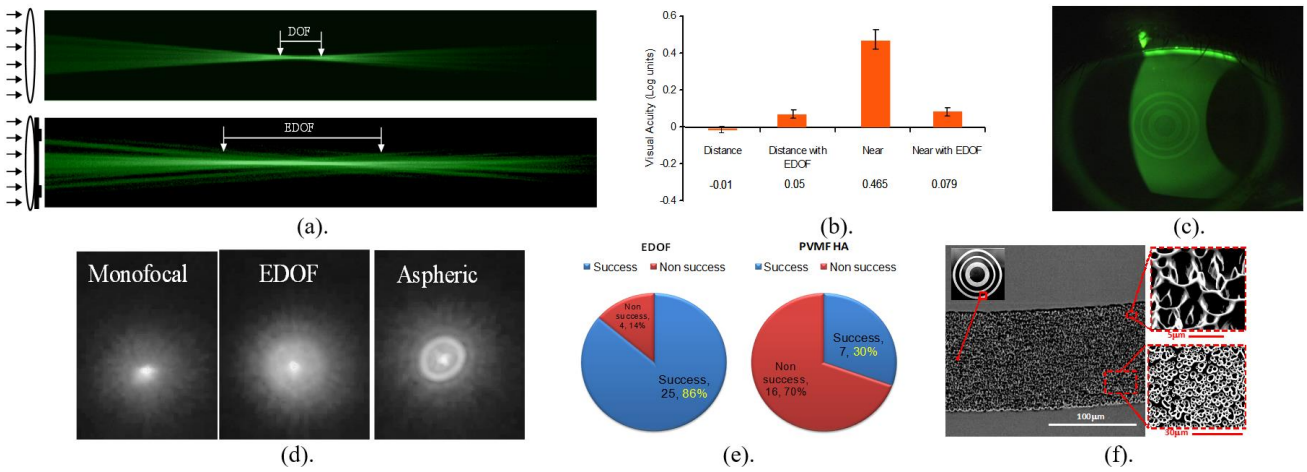

Figure 1. (a). Experimental results of DOF of regular lens vs. the EDOF lens. (b). Clinical trials of EDOF lens done on presbyopia patients. (c). A soft CL with EDOF patterns while being worn by a patient. (d). Halo effect experiment in which point source is imaged by monofocal, EDOF RGP and aspheric RGP CL. (e). Large scale clinical trials where EDOF soft CL is compared to PVMF HA bifocal contact lens. (f). Surface treatment to obtain tears invariance in soft CL.

Abstract

We have developed a unique concept to solve presbyopia and to apply it for spectacles, soft and rigid CL and to infra-ocular lenses [**1-3**]. The idea is to use the effect of optical interference (rather than refractive or diffractive) for extending the depth of the focus (EDOF) of the lens for about 3 Diopters which allows to have focused imaging over the full field of view without the need of using the accommodation capabilities of the eye (when having presbyopia). The EDOF is obtained by generating transversely large and axially shallow scratches on the surface of the lens modifying the axial interference patterns of rays passing through the aperture of the lens in such a way that EDOF is obtained (the focus of every lens is the point of constructive interference in which all rays passing through the aperture of the lens have exactly the same geometrical path length). Since the scratches are transversely large no chromatic aberrations and energetic losses are induced. Properly treating the surface and modifying the structure inside the scratches allows obtaining optical performance which is not tears sensitive (important for CL). The proposed design also allows obtaining reduced halo effect (very essential for vision in dark conditions as e.g., at night).

Keywords: Presbyopia, interference, extended depth of focus (EDOF), ophthalmology.

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Biography of Presenting Author

Zeev Zalevsky received his B.Sc. and direct Ph.D. degrees in electrical engineering from Tel-Aviv University in 1993 and 1996 respectively. Zeev is currently a full Professor and the Dean of engineering in Bar-Ilan University, Israel. His research involves optical super resolution, biomedical optics and nano-photonics/technology. Zeev has published more than 850 papers, 9 books, 30 book chapters and about 100 patents. Zeev gave 600 conference presentations with more than 200 invited/keynote/plenary talks. Zeev is a fellow of many large scientific societies as SPIE, OSA, IEEE, EOS, IOP, IET, IS&T, NAI and more. For his work he received many national and international prizes as Krill prize, ICO prize, SAOT prize, Juludan prize, Taubelnblatt prize, young investigator prize in nanotech, International Wearable Technologies Innovation World Cup, Image Engineering Innovation Award, NANOSMAT prize, SPIE prism award, International Photonic Award, Horace Furumoto award, Asian Advanced Materials Award, Edison Award and more.

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