An Accommodative Contact Lens for Presbyopic Correction

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Presbyopia is the most common ocular affliction and presents an extraordinary public health issue. Our goal is to correct presbyopia by developing a new type of contact lens called an accommodative contact lens (ACL) that incorporates a tunable lens for accommodation and devices to convert light energy to electricity and store it *in situ* for the operation. We first demonstrate different types of flexible lenses based on electrowetting on dielectrics, dielectrophoretic force, and Fresnel zone plates. These lenses are fabricated onto soft polymers for ultimate integration and embedment into contact lenses. We then report on light energy harvesting devices that can simultaneously achieve storage within the same single device structure. Our approach is to incorporate polyvinylidene fluoride (PVDF) into dye-sensitized solar cells (DSSCs). To improve the charge storage capacity, we developed a novel hydrothermal process to prepare porous hierarchically nanostructured tungsten trioxide (WO_3), and then applied WO_3 to fabricate flexible supercapacitors as a storage device. Compared with traditional carbon electrodes, WO_3 nanomaterials significantly enhanced energy storage capability. In order to improve the light-harvesting efficiency of our device, we introduced a light-trapping structure in the photoelectrode via a femtosecond laser ablation technique. The processed photoelectrode was then used to fabricate DSSCs to enhance the photon-harvesting efficiency (η) by up to 13.5%. Lastly, we report on a fabrication platform to integrate the accommodative liquid lens, control electronics, and energy harvesting and storage device into the soft contact lens for presbyopic correction.