Injectable, self-opening, and freestanding retinal prosthesis for fighting blindness

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Worldwide 190 million people are severely visually impaired, and about 32 million are blind[1]. In Europe, macular degeneration and glaucoma are considered the leading causes of vision loss. Blindness is a widespread global public health issue, representing a significant personal and societal burden, limiting educational opportunities, affecting economic possibilities and reducing the quality of life[2–4]. Although various approaches have been attempted so far, including drug treatment, gene therapy, stem-cells transplantation, optogenetics, and visual prostheses, with encouraging results in animal models and some also in patients[5], there is still no established method to restore sight. Among those, retinal prostheses succeeded in restoring a primitive form of vision[6,7], such as locating and recognizing objects. However, fighting blindness with retinal prostheses requires challenges not yet achieved: implanting a prosthesis (i) large enough to cover the retinal surface and (ii) embedding a high number of highly dense stimulatory elements. We developed an injectable, self-opening, and freestanding prosthesis restoring at least 40° of visual field, therefore covering at least a retinal surface of 12 mm in diameter. Moreover, it has a hemispherical shape in order to minimize the distance from the targeted cells over its entire surface. It also operates according to a photovoltaic stimulation principle and it should be injected trough a minimal scleral incision. Our implant is based on PDMS as shell material, embedding 2345 organic photovoltaic stimulating pixels made of conjugated polymers (100 µm and 150 µm in diameter, density 54 px/mm^2), covering an active area of 13 mm (44° of visual field). Our results indicate that those pixels can deliver up to 54 mA/cm^2 and generate an electrode potential up to 200 mV when illuminated with a pulse light of 10 ms, 32 µW/mm^2, at 530 nm. Accelerated aging tests and experiments with explanted retinas are currently under evaluation. These preliminary results show the potential of organic photovoltaics in the fabrication of a retinal prosthesis with large area and high stimulation efficiency. The biocompatibility and mechanical compliance of the materials represent a step forward in building advanced photovoltaic retinal prostheses.

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