Injectable, Self-opening, and Freestanding Retinal Prosthesis for Fighting Blindness

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Author Block: *Diego Ghezzi[1] , Kevin Sivula[2] , Marta J. Airaghi Leccardi[1] , Laura Ferlauto[1]*
[1] Medtronic Chair in Neuroengineering, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland;
[2] Laboratory for Molecular Engineering of Optoelectronic Nanomaterials, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

Disclosure Block: Diego Ghezzi, None; Kevin Sivula, None; Marta J. Airaghi Leccardi, None; Laura Ferlauto, None

Purpose: In the past decade, retinal prostheses emerged as promising technology to restore a primitive, although clinically useful, form of vision. However, fighting blindness with retinal prostheses require challenges not yet achieved. From a clinical perspective, sight restoration requires to reach two main goals: enlarging the visual field of the patient and improving its visual acuity. From the engineering point of view, these needs demand the overcoming of two major issues: implanting a prosthesis (i) large enough to cover the retinal surface and (ii) embedding a high number of highly dense stimulatory elements. Our goal is the development of an injectable, self-opening, and freestanding retinal prosthesis restoring at least 40° of visual field, therefore covering at least a retinal surface of 12 mm in diameter. Moreover, the prosthesis must have a hemispherical shape in order to minimize the distance from the targeted cells over its entire surface, it should operate according to a photovoltaic stimulation principle and it must be injected trough a minimal scleral incision.

Methods: Using solution processes and micro-fabrication techniques, we designed a retinal prosthesis based on polydimethylsiloxane (PDMS) as shell material, embedding photovoltaic pixels made of conjugated polymers. The prosthesis is shaped with a molding technique.

Results: The prosthesis consists in a photovoltaic PDMS-interface, embedding 2345 organic stimulating pixels (100 µm and 150 µm in diameter, density 54.34 px/mm2) with a biomimetic distribution in an active area of 13 mm (44° of visual field). Our results indicate that those photovoltaic pixels can deliver up to 54.22±10.55 mA/cm^2 and generate an electrode potential of 182.22±6.72 mV when illuminated with a pulse light of 10 ms, 32.47 µW/mm^2, at 530 nm. Sample tested n = 20. Accelerated aging tests and experiments with explanted retinas are currently under evaluation.

Conclusions: These preliminary results show the potential of organic photovoltaic technology in the fabrication of a retinal prosthesis with large surface area and high stimulation efficiency. The biocompatibility and mechanical compliance of the materials represent an additional step forward in building advanced photovoltaic retinal prostheses.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.: