Conjugated polymers nanoparticles to rescue visual functions in a model of retinal degeneration

Elisabetta COLOMBO - *IIT*

The past three decades have witnessed tremendous research in visual restorative therapies, although neurodegenerative retina diseases such as Age related Macular Degeneration (AMD) and Retinitis pigmentosa (RP) remain amongst the top untreatable eye diseases, responsible for debilitating millions of lives. Subretinal approaches showed encouraging results for a partial vision recovery upon photoreceptor degeneration by targeting residual inner retinal neurons denervated by their photosensitive input. Recently, nanoparticles made of photovoltaic polymer Poly(3-hexylthiophene-2,5-diyl) (P3HT) have shown to mediate light-evoked firing of retinal neurons and persistently rescue light sensitivity and visual acuity when subretinally injected in Royal College of Surgeons (RCS) albino rats, a model of RP. Given the promising results of the injectable P3HT nanoparticles *in vivo,* we demonstrated a successful vision rescue in a late stage of the disease in both RCS rats and a pigmented mouse model of retina degeneration (rd10 mouse). Moreover, we enhanced the phototransduction efficiency of the particles by mimicking the heterostructures employed in standard organic photovoltaics with a blend of P3HT with a fullerene-derivative charge acceptor and graphene oxide flakes. The preparation resulted biocompatible *in vivo* upon subretinal injection and showed potential for vision restoration in the RCS rats and the domestic pig from light-driven behavioural experiments and cortical and retinal electrophysiology. These results prove the translability of the liquid retinal prosthesis strategy to medical practice and pave the way towards novel phototransduction architectures based on organic optoelectronics for diagnostic and therapeutic applications.