Application Note: Solid State Batteries for Smart Contact Lenses

Introduction

Originally developed to replace glasses for helping people see better, contact lenses are now moving into a 'smart' era. The market is expected to reach revenues of USD 7.2 billion by 2023 with a CAGR of 10.4%.

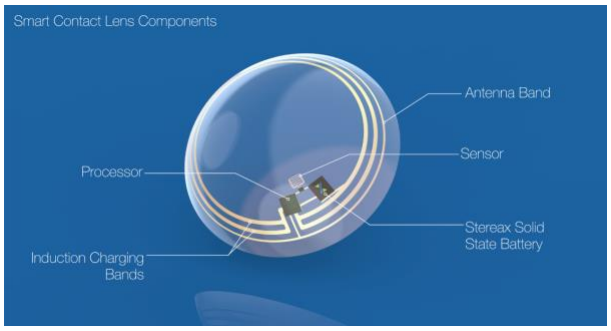
Not only could smart contact lenses revolutionise healthcare for approx. 253 million people worldwide who have some form of vision impairement, but there are plans for them in other areas such as:

- An early application was the non-invasive measurement of glucose levels of diabetic patients, with work still in progress to optimise the efficiency of the measurement
- Other medical uses include diagnosing glaucoma, treatment of presbyopia and as a solution for 'dry eye syndrome'
- Monitoring eye movement to track and diagnose neurological diseases such as Parkinsons and Alzheimers
- Augmented Reality – projecting visual information directly onto the retina of the eye for everyday life and gaming
- Night vision smart contact lens that will enable soldiers to see in the dark using thermal imaging
- Turn your eye into a camera, not only taking photos just by blinking, but also storing them on the contact lens itself
- Replacing body-cams for the police and military

To make a normal contact lens smart, key electronic components need to be placed around the edge of the lens so they don't obstruct the wearer's vision. With so little available space, it's vital these components are miniature. These micro components could include:

- A very thin battery
- A micro-processor and communication chip
- Some memory to store data
- A circular antenna band
- Some lenses might require a way of displaying or projecting images on the retina

Powering Smart Contact Lenses



A vision of a solid state battery powered smart contact lens

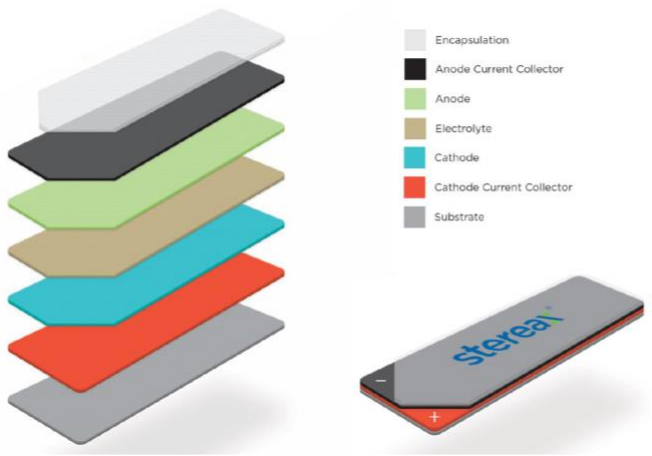
In order for these smart contact lenses to work to their full potential, a safe, ultra-miniature and reliable power supply is key. Early development did not actually place the energy source onto the contact lens, instead the lens was powered wirelessly from a transmitter placed either on the frame of smart glasses or in the person's pocket. However, users found this cumbersome and work is now being carried out to place the battery directly onto the lens; it can be recharged with small solar panels on the lens or at night in their charging case when the lenses are not being worn. The battery must not unintrusive to the wearer as any object thicker than a few hundred microns becomes an irritant to the eye. Hence it must be very thin, with mm-size footprint but enough energy to provide the lens its functionality. Ilika's Stereax solid state battery technology offers all this and more.

A vision of a charging station for smart contact lenses

Ilika Technologies Ltd, Unit 10a The Quadrangle, Abbey Park Industrial Estate, Romsey, Hampshire SO51 9DL

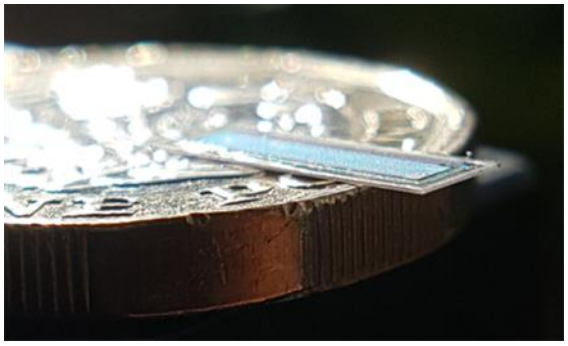
Tel: +44 (0)23 8011 1400 | Email info@ilika.com | www.ilika.com | /ilika-plc | @ilikaplc

Stereax® Solid State Battery



Graphic representation of Stereax solid state battery

Ilika's Stereax are customisable solid state batteries designed with smart contact lenses applications in mind. Ultra-thin, they can be stacked on top of each to increase their energy and still be only a few hundered microns thick and comfortable to wear. Their footprint can also be very small to fit on the periphery of contact lenses and not disturb sight. These batteries are fully solid and will not leak toxic liquids or explode.



Miniature Stereax solid state battery basic unit cell

The way these batteries are constructed is based on the thinning of a basic unit "cells", similar to the example above, but stacked and customised so that they fit with the xyz available dimensions on contact lenses, as below.

The **Stereax M50** and **M300 (the 6-stack version of the M50)**, are demonstrations of Ilika's micro-batteries, available for evaluation at the **end of 2020**:

- 5.6 x 3.6 mm
- 0.15 mm (M50); 0.9 mm (M300) thick
- 50/300 μAh
- 0.5/3 mA standard current

Further to this demonstration batteries, Ilika is also developing Solid State Batteries for contact lenses, available soon:

- 1.3 x 2.5 mm
- 0.15 mm thick
- 10 μAh
- 150 μA peak current

Graphic representation of stacked Stereax solid state battery

With their all-solid state construction, low self discharge and no free lithium, Stereax micro batteries offer the safe power source required by future innovations using smart contact lenses for healthcare or augmented vision.

Benefits of Stereax Solid State Battery

- Ultra thin (currently 150 μm single cell, sub-100 μm cell in development)
- Stackable (at least 6 cells in development)
- Miniature footprint (a few mm dimensions)
- Customisable shape and size (square, long, thin, rectangular, circular etc…)
- Fast charge (<10 min on fast charge; 1 hour for standard usage)
- High energy density (targeting 200 Wh/L)
- Thousands of cycles, depending on Depth of Discharge (5000 cycles at 10% DoD)
- Low self discharge (nA)
- Compatible with energy harvesting and wireless charging
- Safe: won't leak, burn or explode

For more information and to discuss how the Stereax solid state batteries can help your smart contact lens project, contact us on info@ilika.com or visit https://www.ilika.com/battery-innovation/stereax-m50