Hydrogel Soft Contact Lenses as Eye Health Monitoring Wearables

Track Code: 2020-LEE-68805

Categories:
- Biomedical Engineering
- Biotechnology

Keywords:
- Active Monitoring
- Biomaterials
- Biomedical Engineering
- Biotechnology
- Drug Delivery
- Eye Disease
- Flexible Electronics
- Glaucoma
- Hydrogel
- Lenses
- Medical Diagnostics
- Monitor
- Nanoelectronics
- Patient Care
- Printing
- Wearable Electronics
- Wearable Medical Device
- Wearable Sensor

Researchers at Purdue University have developed a method for transferring electronics to soft hydrogel-based contact lenses. These lenses can be used to continuously monitor glucose, intraocular pressure, myasthenia gravis, and even Parkinson's disease for millions of patients globally. Currently, electronic technologies with sensing capabilities are not adaptable with flexible commercial contact lenses. Therefore, special plastics such as polyethylene terephthalate (PET) derivatives or SU8 resins (bisphenol A novolac epoxy) have been developed; however, these exhibit limitations in oxygen permeability, symptoms of dry eye, and discomfort in curvature upon wear. Contact lenses for vision correction should be curved, thin, and durable for eyelid movement and lens fitting. The Purdue University approach improves patient experience by integrating a new electrochemical printing technique between biosensors and soft hydrogel lenses. Pre-fabricated electronics are readily removed from Silicon-based wafers and bound them by polymerization onto lenses in order to enhance lens strength,

stability, and hydration within the eye. In addition, these contacts have potential to connect with software that can regularly upload measurements to users and doctors.

Advantages:
-Rapid monitoring for variety of eye diseases
-Non-invasive
-Biocompatible
-Oxygen Permeability & Wettability
-Ergonomic Curvature

Potential Applications:
-Diagnostic Tool for Ocular Diseases
-Remote Glucose Monitoring
-Glaucoma monitoring/detection
-Biotechnology

Co-inventor: Dr. Bryan Boudouris

Bryan W. Boudouris is a professor in the Charles D. Davidson School of Chemical Engineering and a professor (by courtesy) in the Department of Chemistry at Purdue University. He received his B.S. in Chemical Engineering from the University of Illinois at Urbana-Champaign in 2004. After receiving his Ph.D. in Chemical Engineering from the University of Minnesota in 2009, he conducted postdoctoral research from 2009 to 2011 at the University of California, Berkeley and Lawrence Berkeley National Laboratory. Since joining Purdue University in 2011, he has been the recipient of a number of awards including the AFOSR YIP award, the DARPA YFA, the NSF CAREER Award, the AIChE Owens Corning Early Career Award, the Saville Lectureship at Princeton University, and the John H. Dillon Medal from the APS. His group's current research interests include the design, nanostructural characterization, and implementation of homopolymers and block polymers in applications that encompass: polymer-based energy conversion and bioelectronic sensing devices; membranes with high fluxes and high selectivities; high-performance gas sensors that are functionalized with soft materials; and the creation of photopolymerized materials using continuous 3-dimensional (3D) nanoprinting.

For more information, visit Dr. Boudouris's Purdue website: https://engineering.purdue.edu/ChE/People/ptProfile?id=71151
or his POWER Lab Research Group's website: https://engineering.purdue.edu/Powerlab/Pages/MainPages/Home.html
https://engineering.purdue.edu/ChE/People/ptProfile?id=71151 https://engineering.purdue.edu/Powerlab/Pages/MainPages/Home.html

Technology Validation:
Purdue researchers have fine-tuned their new contact lens materials with mechanical modulus 0.2-2.0 MPa, approximately 100% transparency, 10-200 Dk/t oxygen permeability, and 30-80% wettability with corneal shapes between 8.3-9.0 mm curved radii and adapted them with a lightweight wire 1.4 mg/cm in density with up to 350% elasticity to allow for eye blinking and rotational movements about +/- 4 mm. In testing in vitro, human corneal epithelial cells were seeded onto the surface of the lenses and maintained 95% cell viability over 24 hours.

People:

- Lee, Chi Hwan (Project leader)
- Boudouris, Bryan William

Intellectual Property:

Application Date: July 1, 2021
Type: Utility Patent
Country of Filing: United States
Patent Number: (None)
Issue Date: (None)

Application Date: July 2, 2020
Type: Provisional-Patent
Country of Filing: United States
Patent Number: (None)
Issue Date: (None)

Contact OTC:

Purdue Office of Technology Commercialization
The Convergence Center
101 Foundry Drive, Suite 2500
West Lafayette, IN 47906

Phone: (765) 588-3475
Fax: (765) 463-3486
Email: otcip@prf.org