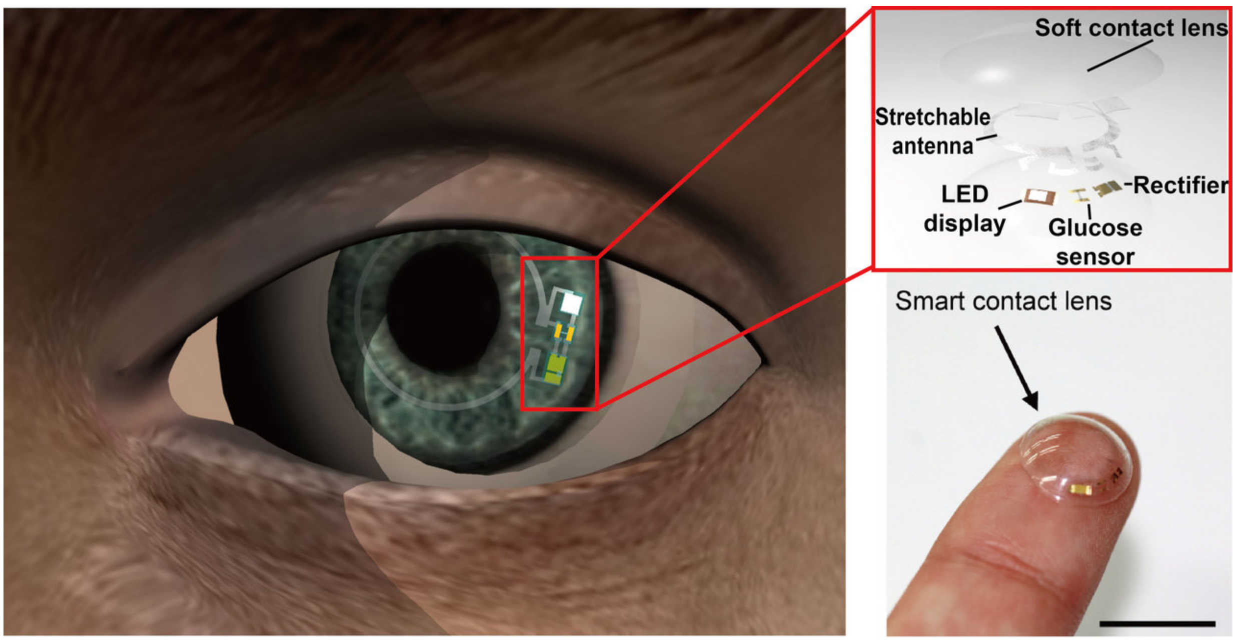
Graphene based glucose-monitoring contact lens comfortable enough to wear

January 25 2018, by Bob Yirka



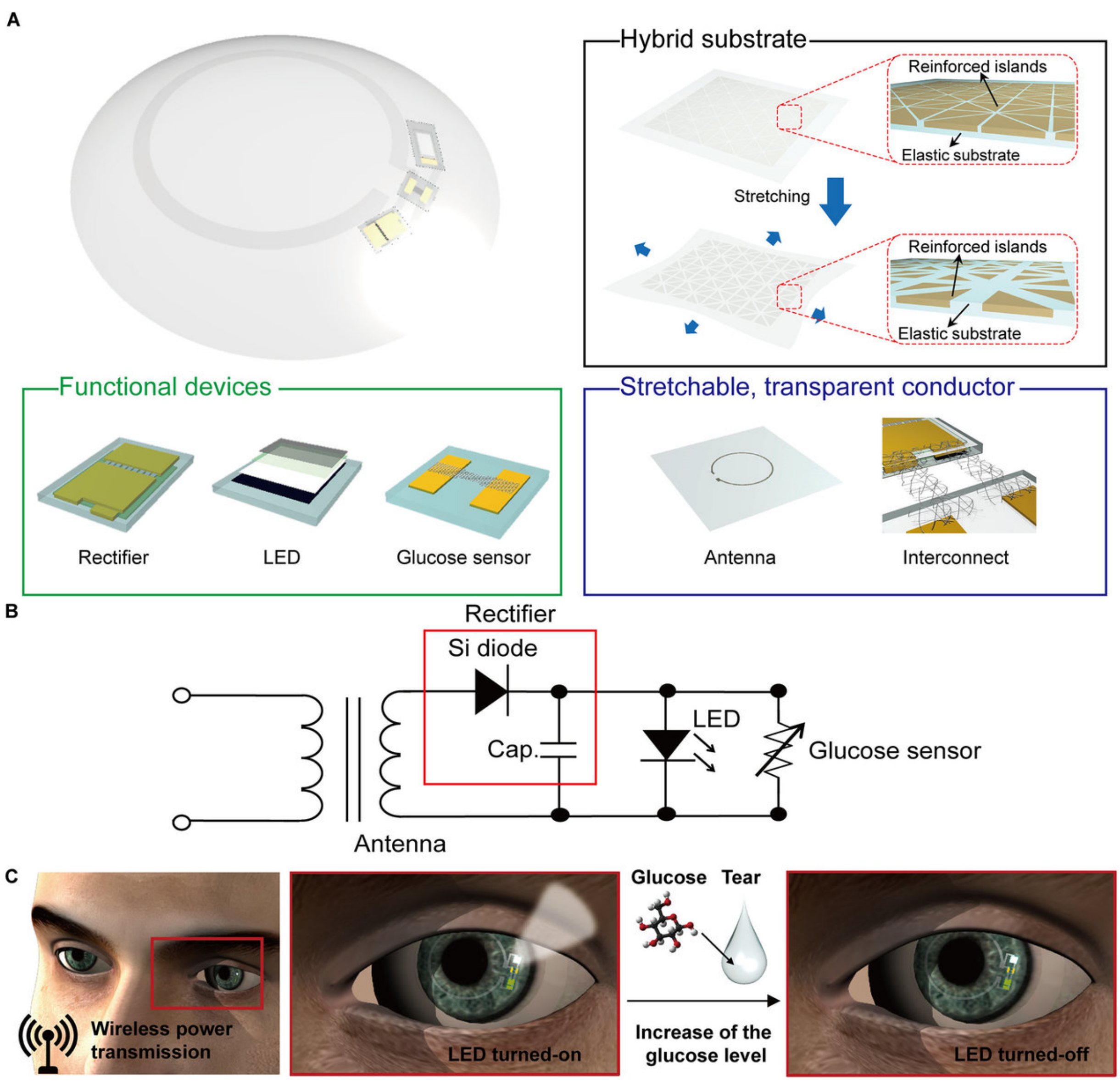
Overview of the soft, smart contact lens to monitor glucose levels in tears. Credit: Jang-Ung Park, UNIST

A team of researchers with the Ulsan National Institute of Science and Technology in the Republic of Korea has developed a glucose monitoring contact lens that its makers claim is comfortable enough to wear. In their paper published on the open access site *Science Advances*, the group describes their contact lens and suggests it could be ready for commercial use within five years.

Diabetes results in unmanageable glucose levels, requiring those who have the disease to monitor and adjust them with insulin or medicine. Monitoring, unfortunately, requires pricking a finger to retrieve a blood sample for testing, which most people do not like. For that reason, scientists seek another way. A new method employs a contact lens. Prior research has shown glucose levels in tears follows that of glucose levels in the blood in many respects. To date, there are no commercially available contact lens products because, as the researchers note, they are made of hard materials that are uncomfortable in the eye. They claim to have overcome that problem by breaking apart the pieces of their sensing device and encapsulating each in a soft polymer and then connecting them together in a flexible mesh.

The polymer is the same type used in conventional contact lenses. The components of the device consist of a graphene-based sensor, a rectifier, LED display and a stretchable antenna. Power for the sensor is still external—it is held in the air a minimum of nine millimeters from the lens. The LED glows during normal conditions and turns off when high levels of glucose are detected. The flexibility of the lens and sensor components also allows for removal of the device in the same way as normal contact lenses—by grabbing and bending.

The team reports that thus far, they have tested the contact lens sensor system in rabbits and found it works as planned and does not cause eye irritation. They also looked through the lens with a camera to make sure that the tiny sensor embedded in the edges of the lens did not impede vision. The team plans to continue refining their lens sensor and believes they will have a product ready for commercial use within five years.



Stretchable, transparent smart contact lens system. (A) Schematic illustration of the soft, smart contact lens. The soft, smart contact lens is composed of an integrated hybrid substrate, functional devices (rectifier, LED, and glucose sensor), and a transparent, stretchable conductor (for antenna and interconnects). (B) Circuit diagramof the smart contact lens system. (C) Operation of this soft, smart contact lens. Electric power is wirelessly transmitted to the lens through the antenna. This power activates the LED pixel and the glucose sensor. After detecting the glucose level in tear fluid above the threshold, this pixel turns off. Credit: Park et al., *Sci. Adv*. 2018;4: eaap9841

More information: Jihun Park et al. Soft, smart contact lenses with integrations of wireless circuits, glucose sensors, and displays, *Science Advances* (2018). DOI: 10.1126/sciadv.aap9841

Abstract
Recent advances in wearable electronics combined with wireless communications are essential to the realization of medical applications through health monitoring technologies. For example, a smart contact lens, which is capable of monitoring the physiological information of the eye and tear fluid, could provide real-time, noninvasive medical diagnostics. However, previous reports concerning the smart contact lens have indicated that opaque and brittle components have been used to enable the operation of the electronic device, and this could block the user's vision and potentially damage the eye. In addition, the use of expensive and bulky equipment to measure signals from the contact lens sensors could interfere with the user's external activities. Thus, we report an unconventional approach for the fabrication of a soft, smart contact lens in which glucose sensors, wireless power transfer circuits, and display pixels to visualize sensing signals in real time are fully integrated using transparent and stretchable nanostructures. The integration of this display into the smart lens eliminates the need for additional, bulky measurement equipment. This soft, smart contact lens can be transparent, providing a clear view by matching the refractive indices of its locally patterned areas. The resulting soft, smart contact lens provides real-time, wireless operation, and there are in vivo tests to monitor the glucose concentration in tears (suitable for determining the fasting glucose level in the tears of diabetic patients) and, simultaneously, to provide sensing results through the contact lens display.

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