

Flexible optical sensors to control the quality of beverages and environmental parameters

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Researchers from Universidad Politécnica de Madrid (UPM) have developed an innovative optical sensor using conventional tape, a low-cost and flexible material that can be easily acquired at stationery shops. It can detect variations of the optical properties of a liquid when is immersed. The sensor can be used to control both the quality of beverages and environmental monitoring.

Light from an LED is introduced in one of end of a piece of tape and the light that emerges from the other end is detected through a photodiode. The light coupling to the flexible [waveguide](#) is mediated by a diffractive element using a grating with aluminum lines of nano dimensions; it is added to the tape through a simple process of "tear and paste." Both ends of the waveguide can be easily adhered to the LED emitter and the light detector (photodiode).

Because of the flexibility of the tape, the waveguide can bend and is partially immersed in the liquid under examination. Due to the waveguide bend, part of the propagated light is lost by radiation. This curvature loss depends on the refractive index of the surrounding medium. Thus, it is possible to detect variations of the refractive index of the liquid by photodiode measurement of the optical power lost during the path of [light](#) through the immersed waveguide.

The refractive index of a [liquid solution](#) is related to both its physical and chemical properties, including density and concentration. Thus, researchers can assess, for example, the maturation degree of grapes by

measuring the refractive index of grape juice; it could also detect the alcoholic content of certain beverages. The sensor can be used in the food sector for process control and beverage quality, and in the environmental sector for water quality control.

The materials and components used to develop this sensor are common and inexpensive. Additionally, the assembly of the three main components of the sensor is simple and there is no need for instrumentation or specialized tools. Therefore, the assembly can be carried out by non-qualified personnel.

Dr. Carlos Angulo Barrios, the lead researcher for this project, says, "These features, along with the flexibility of the tape, make this sensor very advantageous regarding other optical instruments for the detection of [refractive index](#) more complex, rigid and expensive, especially in field applications and on-site analysis of liquids in areas of difficult access."

More information: Barrios, C.A. "Rapid on-site formation of a free-standing flexible optical link for sensing applications". *Sensors*, vol. 16 (1643), pp. 1-11, 2016.

Barrios, C.A.; Canalejas-Tejero, V. "Compact discs as versatile cost-effective substrates for releasable nanopatterned aluminium films. *Nanoscale*, vol. 7, pp. 3435–3439, 2015.

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