Universidad de Granada

New wristband provides personalised and real-time tracking of UV exposure

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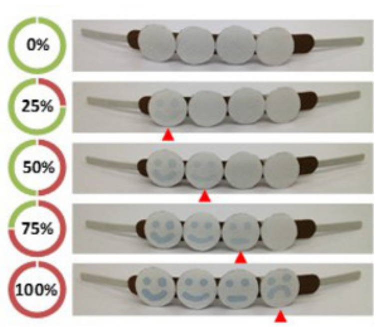
Research news

Researchers from the University of Granada and RMIT University in Melbourne have developed personalised and low-cost wearable ultraviolet (UV) sensors that warn users when their exposure to the sun has become dangerous.

The paper-based sensor, which can be worn as a wristband, features happy and sad emoticon faces—drawn in an invisible UV-sensitive ink—that successively light up as you reach 25%, 50%, 75% and finally 100% of your daily recommended UV exposure.

The research team have also created six versions of the colour-changing wristbands, each of which is personalised for a specific skin tone — an important characteristic given that darker people need more sun exposure to produce vitamin D, which is essential for healthy bones, teeth and muscles.

The groundbreaking research findings were published last week in the prestigious international journal Nature Communications.



The emoticon faces on the wristband successively “light up” as exposure to UV radiation increases

Skin cancer, one of the most common types of cancer throughout the world, is primarily caused by overexposure to ultraviolet radiation (UVR). In Spain, over 74,000 people are diagnosed with non-melanoma skin cancer every year, while a further 4,000 are diagnosed with melanoma skin cancer. In regions such as Australia, where the ozone layer has been substantially depleted, it is estimated that approximately 2 in 3 people will be diagnosed with skin cancer by the time they reach the age of 70.

"UVB and UVC radiation is retained by the ozone layer. This sensor is especially important in the current context, given that the hole in the ozone layer is exposing us to such dangerous radiation", explains José Manuel Domínguez Vera, a researcher at the University of Granada's Department of Inorganic Chemistry and the main author of the paper.

Domínguez Vera also highlights that other sensors currently available on the market only measure overall UV radiation, without distinguishing between UVA, UVB and UVC, each of which has a significantly different impact on human health. In contrast, the new paper-based sensor can differentiate between UVA, UVB and UVC radiation. Prolonged exposure to UVA radiation is associated with skin ageing and wrinkling, while excessive exposure to UVB causes sunburn and increases the likelihood of skin cancer and eye damage.

Drawbacks of the traditional UV index

Ultraviolet radiation is determined by aspects such as location, time of day, pollution levels, astronomical factors, weather conditions such as clouds, and can be heightened by reflective surfaces like bodies of water, sand and snow. But UV rays are not visible to the human eye (even if it is cloudy UV radiation can be high) and until now the only way of monitoring UV intensity has been to use the UV index, which is standardly given in weather reports and indicates 5 degrees of radiation; low, moderate, high, very high or extreme.

Despite its usefulness, the UV index is a relatively limited tool. For instance, it does not clearly indicate what time of the day or for how long you should be outside to get your essential vitamin D dose, or when to cover up to avoid sunburn and a heightened risk of skin cancer.

Moreover, the UV index is normally based on calculations for fair skin, making it unsuitable for ethnically diverse populations. While individuals with fairer skin are more susceptible to UV damage, those with darker skin require much longer periods in the sun in order to absorb healthy amounts of vitamin D. In this regard, the UV index is not an accurate tool for gauging and monitoring an individual's recommended daily exposure.

UV-sensitive ink

The research team set out to tackle the drawbacks of the traditional UV index by developing an inexpensive, disposable and personalised sensor that allows the wearer to track their UV exposure in real-time. The sensor paper they created features a special ink, containing phosphomolybdic acid (PMA), which turns from colourless to blue when exposed to UV radiation. They can use the initially-invisible ink to draw faces—or any other design—on paper and other surfaces. Depending on the type and intensity of the UV radiation to which the ink is exposed, the paper begins to turn blue; the greater the exposure to UV radiation, the faster the paper turns blue.

Additionally, by tweaking the ink composition and the sensor design, the team were able to make the ink change colour faster or slower, allowing them to produce different sensors that are tailored to the six different types of skin colour.

Applications beyond health

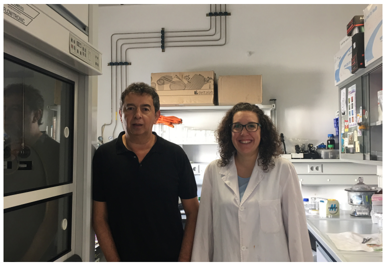
This low-cost, paper-based sensor technology will not only help people of all colours to strike an optimum balance between absorbing enough vitamin D and avoiding sun damage — it also has significant applications for the agricultural and industrial sectors. UV rays affect the growth of crops and the shelf life of a range of consumer products. As the UV sensors can detect even the slightest doses of UV radiation, as well as the most extreme, this new technology has vast potential for industries and companies seeking to evaluate the prolonged impact of UV exposure on products that are cultivated or kept outdoors.

The research project is the result of fruitful collaborations between two members of the UGR BIONanoMet (FQM368) research group; Ana González and José Manuel Domínguez-Vera, and the research group led by Dr. Vipul Bansal at RMIT University in Melbourne (Australia).

Link to the research paper:

Skin color-specific and spectrally-selective naked-eye dosimetry of UVA, B and C radiations, Nature Communications 2018, DOI: 10.1038/s41467-018-06273-3

Contact information:



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