Nanocellulose Combined with Red Onion Dye Offers Efficient UV Shielding for Solar Cells.

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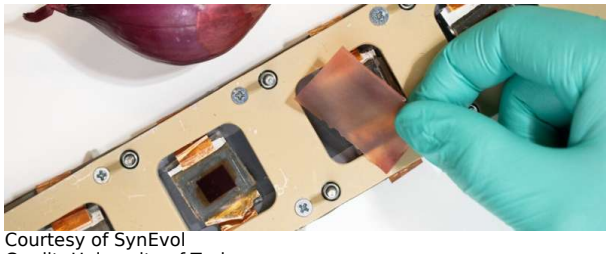

Courtesy of SynEvol
Credit: University of Turku

Scientists from the University of Turku in Finland studied the use of bio-based materials to create efficient UV protection films for solar panels. The research, released in ACS Applied Optical Materials, was the inaugural investigation to examine how the characteristics of various bio-based UV filters evolve over time.

Solar cells are vulnerable to degradation caused by UV exposure and are typically safeguarded against this by films derived from petroleum, like those composed of polyvinyl fluoride (PVF) and polyethylene terephthalate (PET).

Investigations in materials engineering aim to discover substitutes for oil-derived plastics using bio-based materials, one example being nanocellulose. Nanocellulose is produced by reducing cellulose into nanoscale fibers, which can subsequently be processed in various methods to achieve UV protection.

A recent study conducted by the University of Turku and Aalto University in Finland, along with Wageningen University in the Netherlands, discovered that nanocellulose infused with red onion skin extract offers highly effective UV protection. The nanocellulose film shielded 99.9% of UV radiation up to 400 nanometers. This UV filter surpassed the commercial PET-based UV filter that was chosen for the study as a benchmark for market standards.

"Films made of nanocellulose that have been dyed with red onion present a promising alternative for uses where the protective material needs to be bio-based," states Doctoral Researcher Rustem Nizamov from the University of Turku.

The research analyzed the strength and characteristics of four varieties of protective films derived from cellulose nanofibers. The nanocellulose films were individually treated with red onion extract, lignin, and iron ions, each of which has demonstrated effective UV-blocking properties in prior studies. The film infused with the red onion extract demonstrated the highest effectiveness in blocking UV radiation.

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Credit: University of Turku

UV radiation (under 400 nm) can damage solar cells; however, the passage of visible light and some infrared light too (especially from 700 to 1,200 nm) is crucial, since solar cells convert this radiation into electricity.

Creating bio-based materials frequently requires balancing UV protection with light transmission in the visible spectrum. For example, lignin, a natural polymer recognized for its UV-absorbing characteristics, has a deep brown hue that restricts its application in transparent films.

The film dyed with red onion demonstrated to be an intriguing solution, achieving over 80% light transmission at longer wavelengths (650–1,100 nanometers). The movie also upheld its performance during the extended trial phase.

The filters' resilience and efficiency were evaluated under artificial lighting for 1,000 hours, roughly corresponding to a year's worth of sunlight in the open air within a central European climate. Digital photography was used to observe visual changes in the solar cells and filter materials.

The research highlighted the necessity of extended testing for UV filters, since the UV protection and light transmittance of other bio-based filters varied considerably as time passed. “For instance, the films applied with iron ions exhibited strong initial transmittance that diminished after aging,” states Nizamov.

The UV filter films were evaluated on dye-sensitized solar cells, as these cells are especially prone to damage caused by UV radiation.

"According to Nizamov, these findings are significant for the UV protection of various solar cell types, such as perovskite and organic photovoltaics, along with any application where employing a bio-based UV filter is essential."

In the future, the goal of the researchers is to create biodegradable types of solar cells that can serve as energy sources for sensors, such as those used in food packaging.

The timber industry aims to create new premium products. "In electronics, these could also serve as components for solar cells," states Kati Miettunen, a Professor in Materials Engineering.
