

True wearable displays: Self-powered, washable and wearable

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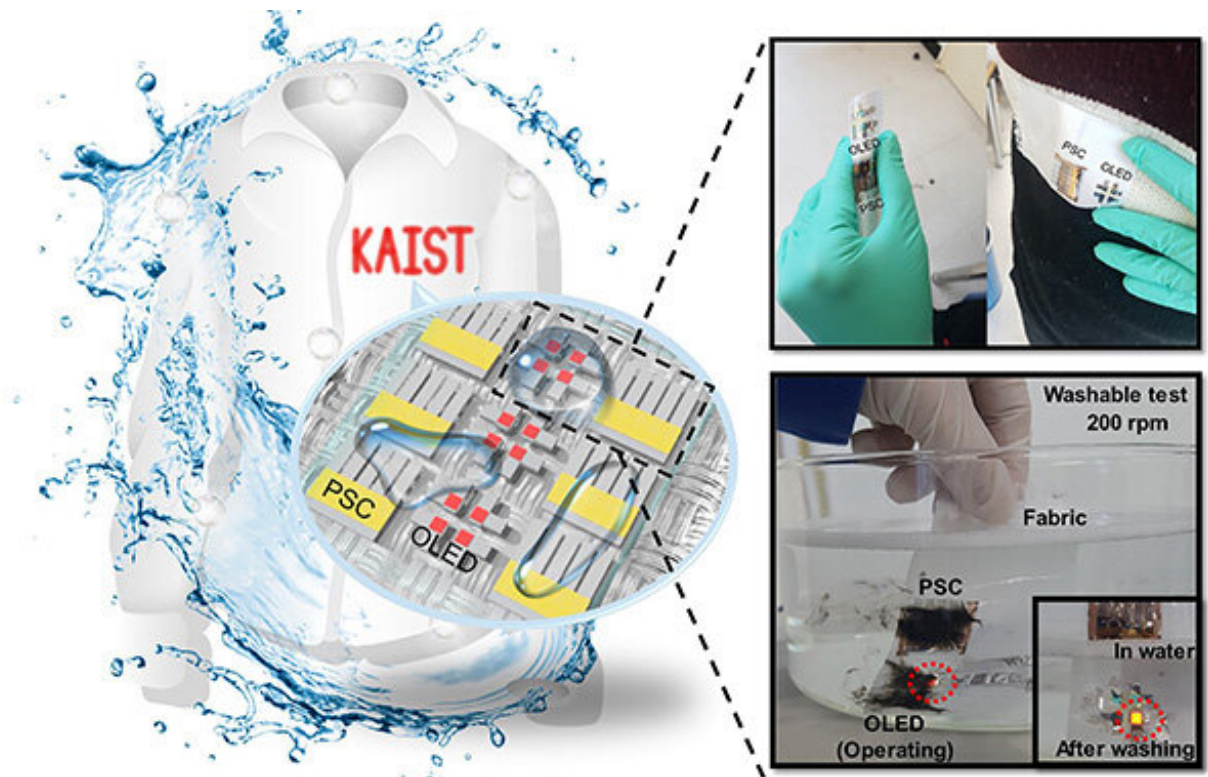


Figure 1. Schematic and photo of a washable wearing display module. Credit: The Korea Advanced Institute of Science and Technology (KAIST)

Clothes are usually made of textiles and have to be both wearable and washable for daily use; however, smart clothing presents a challenge with its power sources and moisture permeability, which causes the devices to

malfunction. This problem has now been overcome by a KAIST research team, who developed a textile-based wearable display module technology that is washable and does not require an external power source.

To phase out external [power](#) sources and enhance the practicability of wearable displays, Professor Kyung Cheol Choi from the School of Electrical Engineering and his team fabricated their wearable display modules on real [textiles](#) that integrate polymer [solar cells](#) (PSCs) with organic light emitting diodes (OLEDs).

PSCs are one of the most promising candidates for next-generation power sources, especially for wearable and optoelectronic applications, because they can provide stable power without an external [power source](#), while OLEDs can be driven with milliwatts. However, the problem is that they are both vulnerable to external moisture and oxygen. The encapsulation barrier is essential for their reliability. The conventional encapsulation barrier is sufficient for normal environments; however, it loses its characteristics in aqueous environments such as water. It limits the commercialization of wearable displays that must operate even on rainy days or after washing.

To tackle this issue, the team employed a washable encapsulation barrier created through atomic layer deposition (ALD) and spin coating. It can protect the device without losing its characteristics after washing. With this encapsulation technology, the team confirmed that textile-based wearable display modules including PSCs, OLEDs, and the proposed encapsulation barrier exhibited little change in characteristics, even after 20 washings with 10-minute cycles. Moreover, the encapsulated device operated stably with a low curvature radius of 3 millimeters and boasted high reliability.

Finally, it exhibited no deterioration in properties over 30 days, even

after being subjected to bending stress and washing. Since it uses a less stressful textile compared to conventional wearable electronic devices that use traditional plastic substrates, this technology can accelerate the commercialization of wearable electronic devices. Importantly, this wearable electronic [device](#) can save energy through a self-powered system.

Professor Choi said, "I could say that this research realized a truly washable wearable electronic module in the sense that it uses daily wearable textiles instead of the plastic used in conventional wearable electronic devices. Saving energy with PSCs, it can be self-powered, using nature-friendly solar energy, and washed. I believe that it has paved the way for a true wearable [display](#) that can be formed on [textile](#), beyond the attachable form of wearable technology."



Figure 2. Cover page of Energy and Environmental Science

More information: Eun Gyo Jeong et al. Textile-based washable polymer solar cells for optoelectronic modules: toward self-powered smart clothing, *Energy & Environmental Science* (2019). [DOI: 10.1039/c8ee03271h](https://doi.org/10.1039/c8ee03271h)

Provided by The Korea Advanced Institute of Science and Technology (KAIST)

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