New technology for energy device that heals itself from damage incurred while generating electricity

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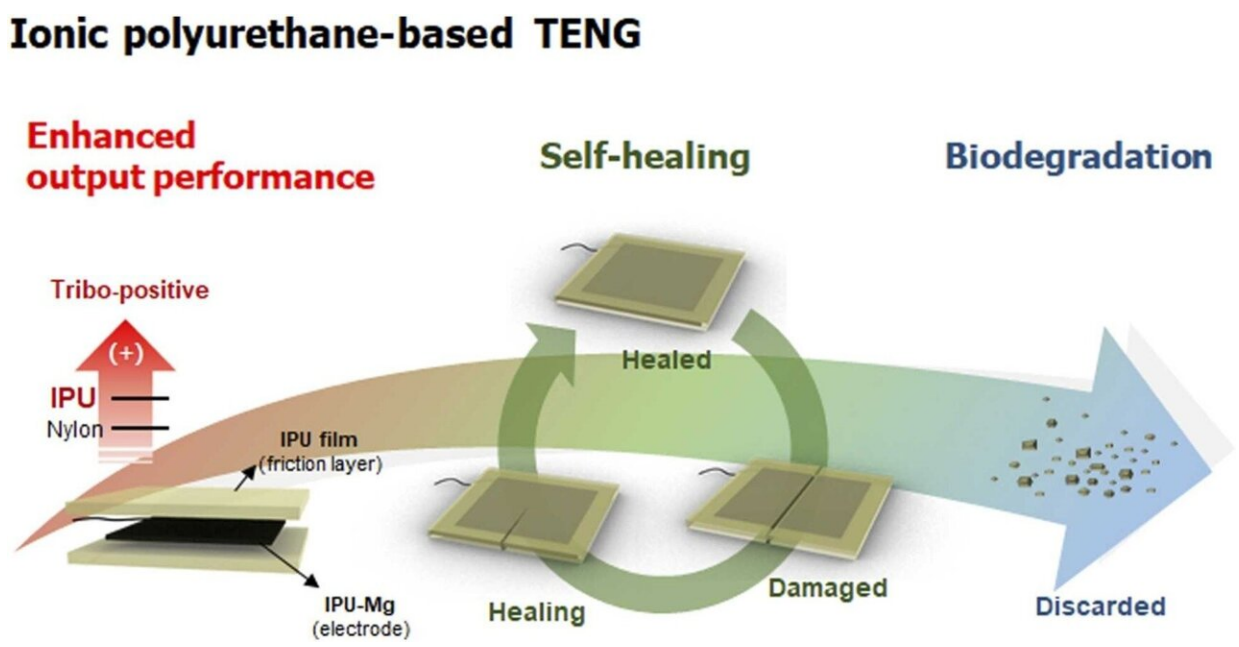

Graphical abstract. Credit: *Nano Energy* (2024). DOI: 10.1016/j.nanoen.2024.109706

A team led by Professor Lee Joo-hyuk of the Department of Energy Engineering at DGIST has developed an ionic polyurethane-based triboelectric generator with self-healing, biodegradable, and high electro-positive properties. The work is published in the journal *Nano Energy*.

The device has been designed as a green energy device that can minimize the impact on the environment by facilitating self-healing and biodegradability, while significantly enhancing power output performance through the use of ionic liquid. Based on these properties, it is expected to be used as a sustainable power source in next-generation soft electronic devices and wearable devices.

In recent years, significant research has been conducted on the use of "triboelectric generators," which convert kinetic energy into electrical energy through friction, as a next-generation power source. For this purpose, high durability and stable power production are essential, and the device must be able to self-heal mechanical damage caused by continuous friction.

The device will demonstrate greater value if, using eco-friendly technology, it can be decomposed with microorganisms and returned to nature after losing its functionality, minimizing harm to the environment.

Professor Lee's team has developed a polyurethane-based triboelectric generator that can be used as an environmentally friendly, next-generation energy source. The research team utilized imidazolium ions for self-healing functions and high electro-positive properties, and polycaprolactone (PCL)-based polyurethane, for biodegradable "ionic polyurethane," to develop a triboelectric generator.

Owing to its self-healing, biodegradable, and high electro-positive characteristics, the ionic polyurethane is highly efficient in producing electrical energy and a sustainable power source for next-generation soft electronic devices, which minimizes the impact on environmental pollution.

The research team conducted a procedure to verify the superiority of the

newly developed device.

By analyzing the power output of the ionic polyurethane-based device under various conditions, they found that it generates a power density of up to 436.8 mW/m^2 and has a self-healing efficiency of approximately 90%. They also found that after 300 days of biodegradation, only about 21% of the initial mass of the device remains.

"Through this research, we have developed an efficient material that integrates self-healing and biodegradation functions, while maintaining high power output performance," said Prof. Lee Joo-hyuk from the Department of Energy Science & Engineering, DGIST.

"This innovative technology can provide a sustainable power source for next-generation wearable devices, and in our follow-up research, we will endeavor to commercialize the technology."

More information: Hyeonseo Joo et al, Engineering self-healable and biodegradable ionic polyurethane with highly tribopositive behavior, *Nano Energy* (2024). DOI: 10.1016/j.nanoen.2024.109706

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