LOW POWER-HIGH PERFORMANCE

Power/Performance Bits: Feb. 1

Seaweed-inspired energy harvesting; algae for artificial photosynthesis.

FEBRUARY 1ST, 2022 - BY: **JESSE ALLEN**

Seaweed-inspired energy harvesting
Researchers from Dalian Maritime University, Georgia Institute of Technology, and Sun Yat-sen University developed flexible power generators that mimic the way seaweed sways to efficiently convert surface and underwater waves into electricity to power marine-based devices.

Networks of sensors are spread across coastal zones, collecting information on currents, tides, water quality, and providing navigation assistance to ships. Often, these sensors rely on batteries that must be replaced and are not in suitable locations to take advantage of solar or wind.

Inspired by the plants living on the seafloor, the researchers developed flexible triboelectric nanogenerators (TENGs). By copying the way strands of seaweed vibrate, the flexible TENGs could harness wave motion.

To make the triboelectric surfaces, the researchers coated 1.5-inch by 3-inch strips of two different polymers in a conductive ink. Then a small sponge was wedged between the strips, creating a thin air gap, and the whole unit was sealed, creating a TENG. In tests, as the TENGs were moved up and down in water, they bent back and forth, generating electricity. When the researchers put the TENGs in water pressures similar to those found underwater in coastal zones, they found that the air gap between the two conductive materials decreased. However, the devices still generated a current at 100 kPa of pressure — the same pressure that typically exists at a 30-foot water depth where there is almost no underwater wave movement.

Finally, the researchers used a wave tank to demonstrate that multiple TENGs could be used as a mini underwater power station, supplying energy for either a thermometer, 30 LEDs or a blinking miniature lighthouse LED beacon. The researchers say their seaweed-like TENG could reduce the reliance on batteries in coastal zones, including for marine sensors.

Imprisoning algae for artificial photosynthesis

Researchers at Nanyang Technological University Singapore are investigating how to improve artificial photosynthesis and found that encasing algae protein in liquid droplets can dramatically enhance the algae's light-harvesting and energy-conversion properties by up to three times.

Artificial photosynthesis is a potential way of sustainably generating electricity, without the waste by-products from manufacturing of solar panels. Alternatively, research into it could also help boost the performance of photovoltaics.

"Artificial photosynthesis is not as efficient as solar cells in generating electricity. However, it is more renewable and sustainable. Due to increasing interest in environmentally-friendly and renewable technologies, extracting energy from light-harvesting proteins in algae has attracted substantial interest in the field of bio-energy," said Assistant Professor Chen Yu-Cheng from the School of Electrical and Electronic Engineering at NTU Singapore.

The researchers looked at a particular type of protein found in red algae, called phycobiliproteins, which are responsible for absorbing light within algae cells to kick-start photosynthesis. "Due to their unique light-emitting and photosynthetic properties, phycobiliproteins have promising potential applications in biotechnology and solid-state devices. Boosting the energy from the light-harvesting apparatus has been at the center of development efforts for organic devices that use light as a power source," said Chen.

In order to amplify the amount of energy that algae can generate, the research team developed a method to encase red algae within small liquid crystal micro-droplets that are 20 to 40 microns in size and exposed them to light.

When light hits the droplet, a "whispering-gallery" effect occurs, in which light waves travel around the curved edges of the droplet. Light is effectively trapped within the droplet for a longer period of time, providing more opportunities for photosynthesis to take place.

“The droplet behaves like a resonator that confines a lot of light,” said Chen. “This gives the algae more exposure to light, increasing the rate of photosynthesis. A similar result can be obtained by coating the outside of the droplet with the algae protein too.”

The researchers said the droplets can be easily produced in bulk at low cost, and propose that it could be used in “algae farms,” where densely-growing algae in bodies of water could eventually be combined with larger liquid crystal droplets to create floating power generators.

“The micro-droplets used in our experiments has the potential to be scaled up to larger droplets which can then be applied to algae outside of a laboratory environment to create energy. While some might consider algae growth to be unsightly, they play a very important role in the environment. Our findings show that there is a way to convert what some might view as ‘bio-trash’ into bio-power,” said Chen.