Self-powered wireless light detectors

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Light detectors are used extensively in daily life as brightness sensors and as receivers for remote control devices in electrical gadgets, for example. However, operating these detectors requires electrical energy, which limits their versatility.

Now, Kui Yao and colleagues from the A*STAR Institute of Materials Research and Engineering in Singapore have developed a photodetector that can harvest just small quantities of detected light to generate enough energy to power a sensing signal transmission through a radio-frequency transmitter.

While the energy contained in a beam of light can be converted into electricity, this energy is not usually sufficient to continuously power an electrical circuit. Even the use of batteries to power a circuit is impractical in many circumstances, explains Yao. "Use of photosensors may take place under extremely harsh conditions intolerable to batteries, or involve environmental monitoring network systems where it may be too expensive or unrealistic to maintain batteries for each sensor."

Operating an electrical circuit under low-power circumstances requires a buildup of energy, which must be generated by the photodetector. However, commonly used photodetector materials, which are based on semiconductors, lose too much energy for this to occur. "Conventional photodetectors can't accumulate the minute photovoltaic energy and then harness it to drive a load in a sustainable manner," explains Yao.

To overcome such energy losses, Yao and colleagues developed photodetectors made from ferroelectric compounds. These insulating materials can separate electrical charges as well as store them with low losses. Ferroelectric detectors can also generate a larger electrical voltage than semiconductors, making it easier for them to power other electrical components.

The researchers connected their ferroelectric detector to a specially designed electrical circuit, which is mechanically opened and closed by a switch in the form of a piezoelectric cantilever. Any generated electricity is temporarily stored in the ferroelectric detector and a capacitor. Once the electrical charge of the capacitor is sufficiently high, the cantilever changes its shape and closes the electrical circuit. This activates a commercial radio transmitter.

So far, the team's main challenge in developing the device has been to minimize electrical losses. Remarkably, Yao and his team have shown that almost 70 per cent of the accumulated electrical charge can be retrieved from the capacitor—even ten minutes after the light source has been switched off. This advantage provides the team's device with the potential for use in a wide range of applications, such as wireless optical sensors and monitoring networks.

More information: Lai, S. C., Yao, K. & Chen, Y. F. "A battery-less photo-detector enabled with simultaneous ferroelectric sensing and energy harnessing mechanism." *Applied Physics Letters* 103, 092903 (2013). dx.doi.org/10.1063/1.4819845

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