Detecting 5-MeV protons using a flexible organic thin-film device

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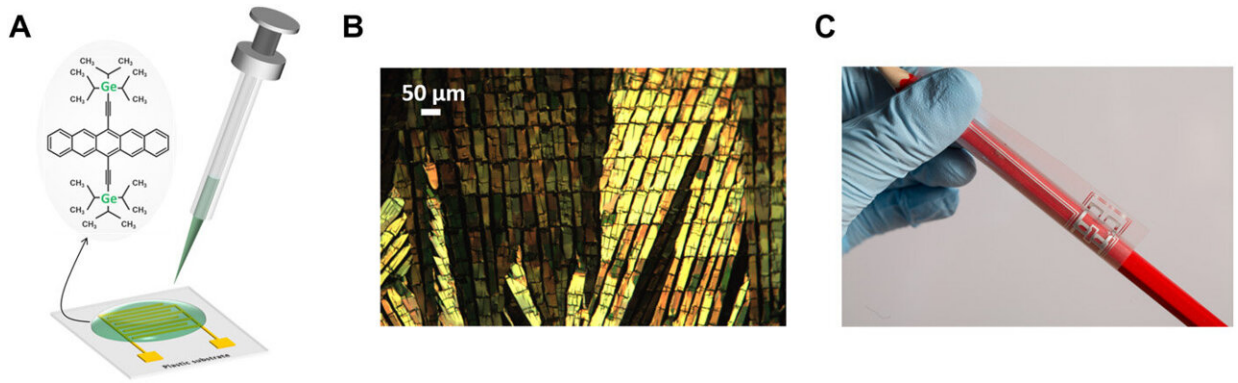

Organic thin film–based device: Architecture and morphology. (A) Coplanar structure composed of two interdigitated electrodes (Au) deposited onto a plastic substrate (125 µm thick) by thermal evaporation. The organic semiconducting thin film is deposited on the top by drop casting, and it is composed of TIPGe-Pn. (B) Optical image of the well-aligned microcrystalline structures forming the thin-film semiconducting layer. (C) Flexibility of the here presented TIPGe-Pn–based detectors. Photo credit: Ilaria Fratelli, Department of Physics and Astronomy, University of Bologna, Italy. Credit: *Science Advances* (2021). DOI: 10.1126/sciadv.abf4462

A team of researchers affiliated with several institutions in Italy and one in the U.S. has developed an organic thin-film device that can be used to measure doses of proton radiation. In their paper published in the journal *Science Advances*, the group describes their semiconductor-based

thin film device and possible uses for it.

As the researchers note, the development of proton-detecting devices has been a goal of physicists for many years because of their use in fundamental research efforts. More recently, such devices have become desirable for proton therapy, in which protons rather than traditional X-rays are fired at cancerous tumors because they can be directed more precisely. In this new effort, the researchers have developed an organic proton detection device. They note that it has advantages over other non-organic devices because its density is very nearly the same as human tissue meaning no recalibration is needed when using it for medical applications.

The detecting device was created by depositing an organic thin film of microcrystalline TIPGe-Pn onto a plastic substrate. As part of the process, the thin film was directed to cover a pair of interdigitated gold electrodes. The researchers note that depositing the thin film was done from a solution, making it a very inexpensive approach to creating a proton detector—they also note that it makes the technique very scalable. And they further note that because the process can be done at low temperatures it can be used to make flexible and possibly portable devices.

The researchers tested their device using a real-time scenario and also in integration mode—protons in a 5 MeV beam were fired at the device using the 3 MV Tandetron accelerator at the LABEC laboratory, in Florence. In so doing the team found the device capable of detecting in the range of 5.15±0.13 pC/Gy with the sensors demonstrating a stable response in ranges from 3.5 x10^{9} and 8.7×10^{11} protons/cm^{2}.

The researchers conclude by suggesting their detector could be used to monitor healthy tissue during proton therapy sessions. They also note that it could also be used by astronauts to measure the amount of

radiation they are absorbing during long missions in space.

More information: Ilaria Fratelli et al, Direct detection of 5-MeV protons by flexible organic thin-film devices, *Science Advances* (2021). DOI: 10.1126/sciadv.abf4462