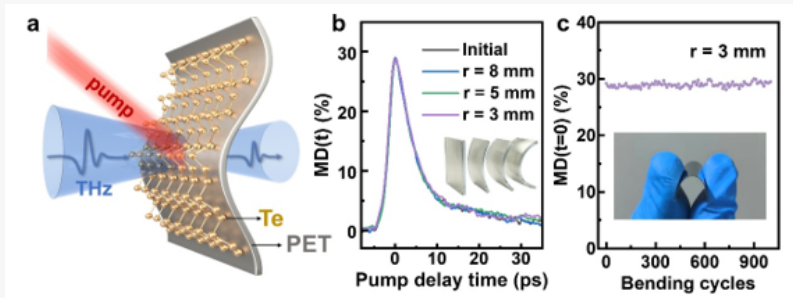
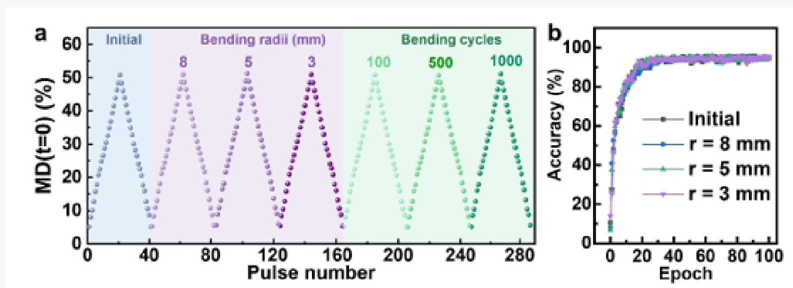
Flexible and robust Te/PET films for ultrafast all-optical terahertz modulators

FAYETTEVILLE, GA, UNITED STATES, August 5, 2026 /EINPresswire.com/ -- Flexible terahertz devices are essential for wearable photonics and intelligent communication systems, yet mechanical deformation can cause information loss and signal interruption. Here, Te nanofilms grown on PET substrates are introduced as flexible all-optical terahertz modulators with high modulation efficiency, picosecond response, low insertion loss, and robust bending tolerance. The device further enables stable neural-network-based image recognition under different bending conditions, providing a route toward flexible intelligent terahertz optoelectronics.



a, Schematic illustration of the Te/PET all-optical terahertz modulator. b, measured transient terahertz responses under different bending radii and c, bending cycles.



a, Measured modulation response under different mechanical states. b, recognition accuracy of ANN based on Te/PET device responses.

Flexible terahertz devices are attracting increasing attention for wearable photonics, intelligent communication, flexible imaging, and sensing systems. In these applications, terahertz modulators serve as key components for controlling terahertz signals. However, practical flexible devices are often exposed to bending deformation, which may induce structural changes, information loss, or signal interruption. Therefore, developing terahertz modulators that maintain high performance under mechanical deformation remains an important challenge.

Tellurium nanofilms provide a promising material platform for this purpose. Te has a unique helical chain structure, good optical response, high carrier mobility, and ambient stability. When integrated with flexible polyethylene terephthalate substrates, Te nanofilms can form mechanically robust and optically active films for terahertz modulation.

In a new paper published in Light: Advanced Manufacturing, a research team led by Professor Qingli Zhou from Capital Normal University and Professor Chen Ge from the Institute of Physics, Chinese Academy of Sciences, developed flexible Te/PET films for ultrafast all-optical terahertz modulators. This device with broadband and low insertion loss achieved a high modulation depth of 50% on the picosecond timescale and an ultrasensitive response under low pump excitation. These results indicate that Te/PET films can provide the foundation for the development of flexible terahertz functional devices.

The researchers further examined the mechanical stability of the device under different bending conditions. The transient terahertz photoresponse remained nearly unchanged after repeated bending cycles and under a small bending radius. This stable response is related to the mechanical tolerance of Te nanofilms and the flexibility of the PET substrate, which help maintain reliable terahertz modulation during mechanical deformation.

To explore the information-processing capability of the device, the team introduced the measured terahertz modulation response into an artificial neural network (ANN) for image recognition. The recognition accuracy remained stable under different bending conditions, showing that the mechanical robustness of the Te/PET device can be translated into reliable information processing. This result suggests that flexible terahertz modulators may serve as front-end functional units for intelligent sensing and neuromorphic optoelectronic systems. These scientists summarize their work:
“We introduce flexible Te/PET films as a mechanically robust platform for ultrafast all-optical terahertz modulation. The device exhibits broadband response, low insertion loss, high modulation efficiency, and picosecond photoresponse, while maintaining stable performance under bending deformation.”

“The stable terahertz response under different mechanical states enables reliable neural-network-based image recognition, suggesting the potential of Te-based flexible terahertz devices for intelligent sensing and wearable optoelectronic systems.” they added.

“The results provide a new device strategy for flexible terahertz modulators and offer guidance for the development of mechanically robust terahertz optoelectronic devices operating in complex deformation environments.” the scientists forecast.

References
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