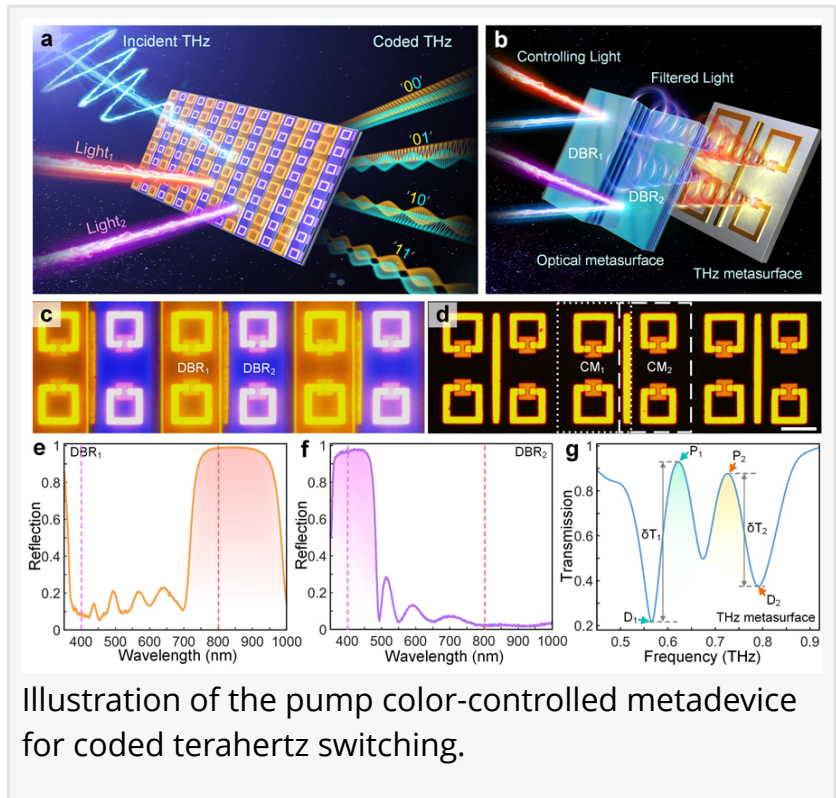


Color Coded Metadevices toward Programmed Terahertz Switching

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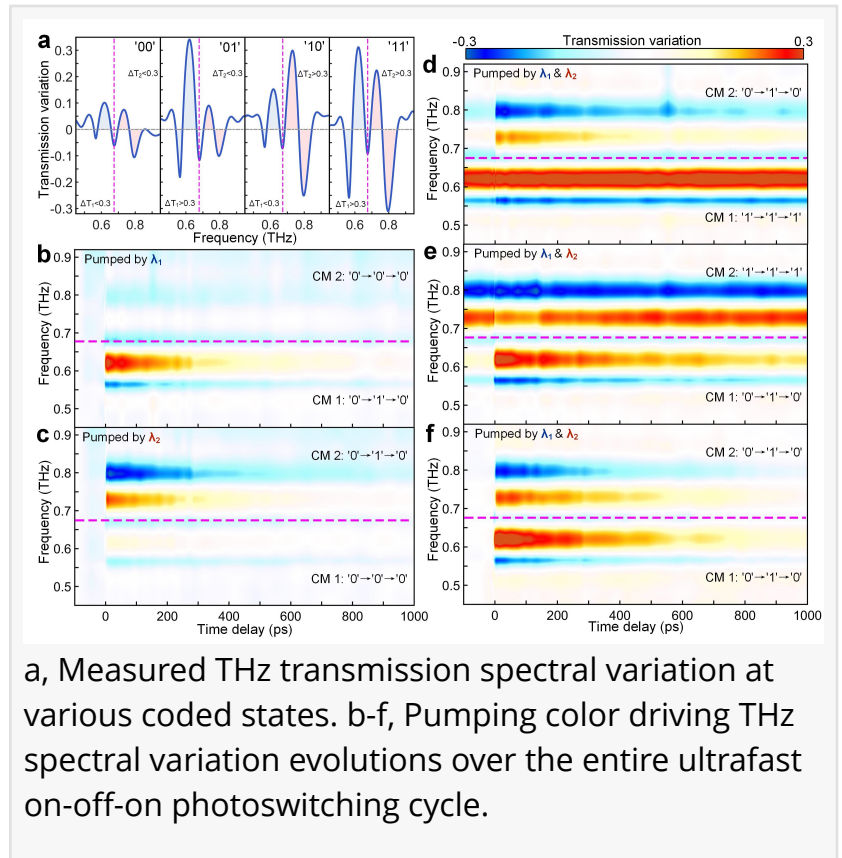
/EINPresswire.com/ -- All-optical [terahertz](#) modulation, an ultrafast dynamical terahertz control approach that has attracted much interest, remains limited in terms of encoding and multifunction. Towards this goal, Scientists in China experimentally demonstrated an optical-programmed terahertz switching realized by combining optical metasurfaces with the terahertz metasurface, resulting in 2-bit dual-channel terahertz encoding. This work establishes a platform for all-optical programmed terahertz metadevices and may further advance the application of composite metasurface in terahertz manipulation.



Terahertz has significant applications in high-speed wireless communication and non-destructive testing as well as in promoting scientific and technological growth. To realize the full potential of terahertz applications, efficient modulators are required. Light-driven reconfigurable terahertz metasurfaces that receive great attention due to their contactless, succinct construction and ultrafast response-ability, have delivered essential assistance for boosting the development of terahertz functional devices. However, optical coding techniques have received comparatively little research. Existing light-code terahertz systems rely on optical masks or spatial light modulators, suffering from single-channel modulation and low coding speed. Hence, further research is needed on integrated and miniaturized light-coded metadevices for programmed ultrafast terahertz switching.

In a new paper (<https://doi.org/10.1038/s41377-024-01495-1>) published in Light Science & Applications, a team of scientists, led by Professor Tian Jiang from Institute for Quantum Science and Technology, College of Science, National University of Defense Technology, Changsha

410073, China has developed an optically controlled terahertz 2-bit encoding device by combing photonic crystals, i.e., arranged Distributed Bragg Reflector (DBR) microstrips, with terahertz metal metasurface. In terahertz metasurfaces, the multimode coupling effect is intended to provide extreme sensitivity, multi-channel resonances, and enhanced modulation efficiency. Intrinsic epitaxial silicon islands are embedded in split resonant resonators (SRRs) of metal metasurface to control its non-radiative loss for ultrafast modulation behavior. The DBR microstrips that block light at 400 nm and 800 nm tightly integrate with the terahertz metasurface structure and are positioned on the metal metasurface units, resulting in different couple mode dissipations controlled by pump-color excitation. We experimentally tested the 2-bit optical terahertz programming behavior on this integrated metadvice. Mutual verification was conducted through experiments and numerical simulations. This strategy provides a new development way for optical coding terahertz modulation and further inspires the exploration of optical programming terahertz devices based on metasurfaces.



The metadvice combines optical metasurfaces and terahertz metasurfaces and may be programmed to produce the required terahertz modulation for different color pumps. It supports 2-bit terahertz code modulation with ultrafast modulation within 1 ns. The way these scientists describe how their metadvice works is as follows:

“(i) When the metadvice pumped by (400 nm), the non-radiative damping of CM1 increases and then the EIT resonance of the left channel is suppressed. (ii) When the metadvice pumped by (800 nm), the loss of CM2 increases and the right channel is quenched. (iii) When the metadvice is simultaneously pumped by and , both EIT resonances disappear.”

“The encoding process is 00-01/10-00 when each color (or) is excited independently ..., showing an ultrafast on-off-on photo-switching cycle within 1000 ps. When two color lights are excited simultaneously, the ultrafast encoding modulation is 00-11-00. Also, alternatively activating one channel while modulating the other allows us to achieve an encoding process of 01/10-11-01/10.” they added.

"This coding approach can be extended to multi-bit information processes and may be applied in the field of optical-controlled terahertz imaging." the scientists forecast.

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