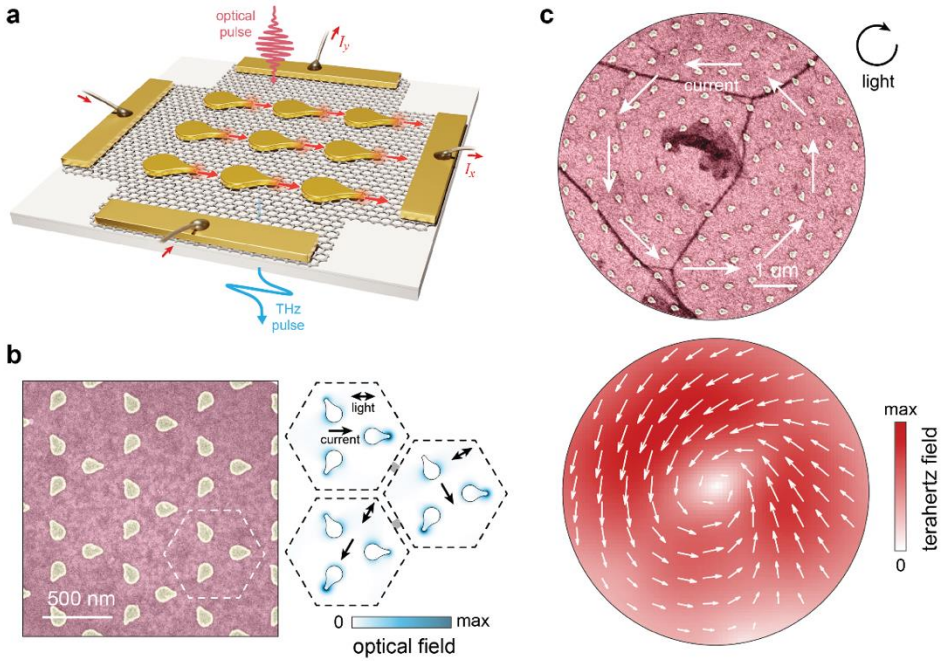
Vectorial Metasurfaces for Ultrafast Light-Based Current Control at the Nanoscale



Local and spatially-varying vectorial currents. a. Illustration of vectorial optoelectronic metasurface concept. b. Kagome metasurface with current driven in any direction (omni-directional control) at the nanoscale unit cell level via incident laser polarization. c. Azimuthal metasurface for azimuthal current and generation of terahertz vector beam.

Pettine, J.; Padmanabhan, P.; Shi, T.; Gingras, L.; McClintock, L.; Chang, C.-C.; Kwock, K. W.; Yuan, L.; Huang, Y.; Nogan, J.; Baldwin, J. K.; Adel, P.; Holzwarth, R.; Azad, A. K.; Ronning, F.; Taylor, A. J.; Prasankumar, R. P.; Lin, S.-Z.; Chen, H.-T. Light-Driven Nanoscale Vectorial Currents. *Nature* 2024.

This work was performed at The Center for Integrated Nanotechnologies.

Scientific Achievement

By combining simple asymmetric structures and simple light fields, a rich landscape of tunable “vectorial” current patterns has been demonstrated for the first time at nanoscopic spatial scales.

Significance and Impact

This unlocks an entirely new level of control over charge flows that cannot be realized by any other means, with broad applications in information processing, microelectronics, terahertz science, materials diagnostics and many other realms.

Research Details

- Asymmetric gold nanostructures (serving as antennas or “lightning rods” for light) drive directional currents in underlying graphene
- First demonstration of arbitrary and actively tunable current patterning (driven by ultrafast light) down to the nanoscale
- Versatile new source of radiation in the terahertz frequency range, including direct generation of elusive terahertz vector beams