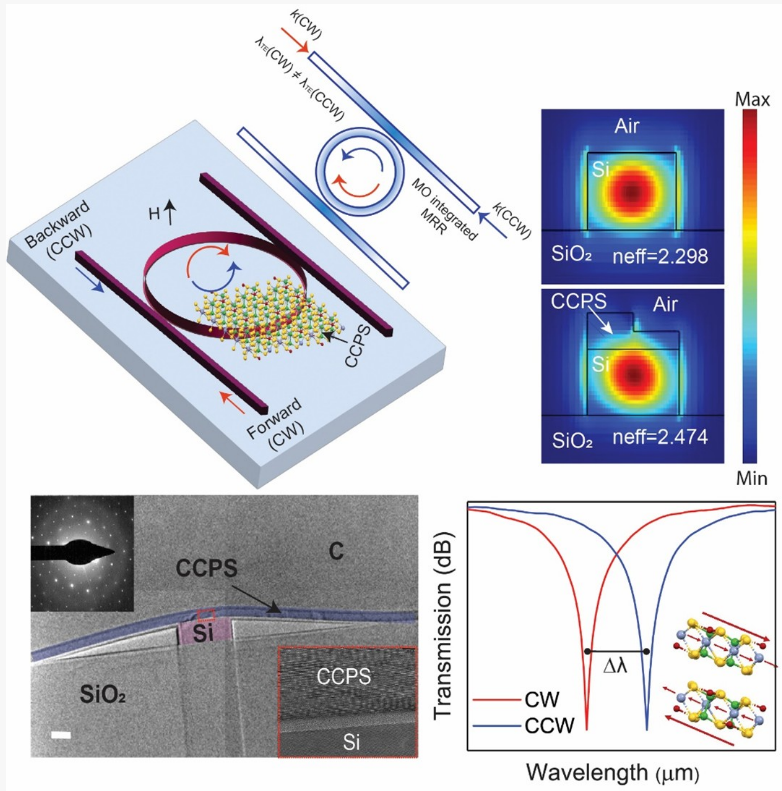
Non-Reciprocal Response in Silicon Photonic Resonators Integrated with 2D CuCrP□S□ at Short-Wave Infrared

GA, UNITED STATES, April 16, 2025 /EINPresswire.com/ -- A major challenge in integrated photonics is achieving efficient non-reciprocal optical behavior. Researchers at NYU Abu Dhabi have demonstrated a non-reciprocal magneto-optic response by integrating the 2D material CuCrP□S□ (CCPS) onto silicon microring resonators. Their device operates in the C-band with low insertion loss and a high isolation ratio, eliminating the need for additional polarization management. This breakthrough paves the way for compact, on-chip optical isolators and advanced photonic devices essential for next-generation optical communication and computing.



a, Schematic of the CCPS/Si microring resonator under an applied magnetic field, showing CW and CCW light propagation differences. b, Electric field intensity profiles for TE modes at 1550 nm for bare and CCPS-integrated waveguides. c, TEM cross-section o

Non-reciprocal optical devices, which break Lorentz reciprocity, are crucial for telecommunications, quantum computing, and optical signal processing. Traditional magneto-optic devices rely on bulky garnet materials, challenging to integrate with silicon photonics due to their large footprint and incompatibility. Researchers at New York University Abu Dhabi (NYUAD), led by Dr. Ghada Dushaq and Professor Mahmoud Rasras, have introduced a novel solution by integrating multilayer CuCrP□S□ (CCPS), a two-dimensional multiferroic material, onto silicon microring resonators (MRRs), achieving a compact, efficient non-reciprocal optical response.

Applying a magnetic field to the CCPS-integrated silicon resonator induces asymmetry between clockwise (CW) and counterclockwise (CCW) propagation due to the material's unique intralayer ferromagnetic ordering and easy-plane magnetocrystalline anisotropy. The team's device exhibits remarkable low insertion loss (0.15–1.8 dB), high isolation (28 dB at 1550 nm), and a resonance splitting of 0.4 nm, corresponding to a 50 GHz bandwidth. Crucially, this technology operates directly in the transverse electric (TE) mode, eliminating the need for additional polarization rotators, thus greatly simplifying integration.

The hybrid CCPS/Si device, featuring compact dimensions (22 μm–55 μm interaction length and 39 nm–62 nm flake thickness), outperforms traditional non-reciprocal platforms in terms of both size and optical losses. The advanced performance, including minimal insertion losses and high isolation, enables practical applications in next-generation optical isolators, modulators, and advanced photonic circuits.

"Our research represents a significant step toward compact, efficient non-reciprocal devices by leveraging the unique properties of 2D multiferroic materials," says Dr. Ghada Dushaq.

Future research will focus on enhancing material integration, reducing device footprint further, and expanding operational bandwidth, paving the way for innovative photonic architectures and practical applications in optical communications and computing.

References
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