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Reconfigurable gradient index using VO2 memory metamaterials

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We have demonstrated tuning of a hybrid metamaterial device that incorporates a form of spatial gradient control. Hybrid metamaterials are constructed through incorporation various non-metallic materials into standard metamaterials structures. Electrical tuning of the metamaterial was achieved through a vanadium dioxide (VO2) layer which interacts with an array of lithographically fabricated gold split ring resonators (SRR). Through design of the device and contact geometry, we achieved a spatial gradient in the magnitude of permittivity, writeable using a single transient electrical pulse which creates dissipative heating in the device. This induced gradient in our device was observed on spatial scales on the order of one wavelength at 1 THz. Additionally, gradients created in such hybrid VO2-SRR devices are persistent, remaining even after the applied voltage has been removed, due to the hysteresis present in the insulator to metal transition of VO2. Thus we have demonstrated the viability of elements for use in future devices with potential applications in beamforming and communications [1]. To continue forward with this research, various contact geometries are currently being investigated in hopes of gaining improved control over gradients and expanding on the possible applications of such devices. Transmission measurements of the full two dimensional spatial extent of the gradients created in these new devices are underway.

[1] M. D. Goldflam, T. Driscoll, B. Chapler, O. Khatib, N. Marie Jokerst, S. Palit, D. R. Smith, B.-J. Kim, G. Seo, H.-T. Kim, M. D. Ventra, and D. N. Basov, Applied Physics Letters 99, 044103 (2011).

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