Near-Zero-Index Materials for Time-Varying Media

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Summary

Very few scientific fields have become as pervasive in basic research and everyday life as nonlinear optics which ushered in tremendous achievements in areas like attosecond physics, ultra-broadband optical communication, and high-resolution sensing. The utility of nonlinear optics has therefore been a compelling motivator to increase generally weak light-matter interactions. In this pursuit, novel materials have been explored including materials where in a particular spectral region the real part of the permittivity (ε)-epsilon is near zero (ENZ) and materials whose losses in that spectral region are also low leading to a near-zero index (NZI). ENZs and NZIs increase light-matter interactions via the enhanced fields at the interface between the 'normal' and ENZ materials, the "slow-light" effects and relaxed phase matching conditions. One important class of novel ENZ/NZI materials is transparent conducting oxides (TCOs) whose lowlosses and high-tunability have made them a leader in NZI-enhanced nonlinear optics like Kerrnonlinearities[1,2] and frequency generation. More recently, transparent conducting oxides have pioneered ultrafast optically-modulated nonlinear optics opening the door to exotic time-varying media phenomena such as negative refraction, time refraction[3], time reflection, and photonic time crystals[4-5].

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