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Transient Wavefront Shaping Based on Waveform-Selective Metasurface

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Wavefront shaping makes it possible to convert an incoming wave to a different wavefront by using compositional subwavelength unit cells, each of which plays a role of a new point source with a particular magnitude and phase [1]. In this study, we demonstrate transient wavefront shaping that exhibits a designed wavefront during a limited time period only. This is achieved by using recently developed waveform-selective metasurfaces, which preferentially absorb or scatter an incident wave even at the same frequency depending on the waveform or pulse width [2, 3, 4]. One of important points of this study lies in broadening a dynamic range of a waveform-selective metasurface. This is because usually each compositional unit cell in wavefront shaping responds to an incoming wave with a different resonant strength, which means that a different level of electromagnetic fields appears around the unit cell, although waveform-selective metasurfaces are designed with diodes (i.e., power-dependent circuits). Due to an improved dynamic range, our waveform-selective metasurface is numerically shown to absorb short pulses in a wide range of power level, while effectively reflecting continuous waves at the same frequency. Such a waveform-selective metasurface is used to control the wavefront of a reflected wave. As seen in Fig. 1, a normal incident wave is numerically predicted to be absorbed if the waveform is sufficiently short (i.e., only during an initial time period). However, the incident wave is reflected with 45 degrees when the wave continues long enough. Potentially, our study contributes to extending the concept of wavefront shaping by exploiting pulse width as a new degree of freedom.

(a) **(b)** **(c)**

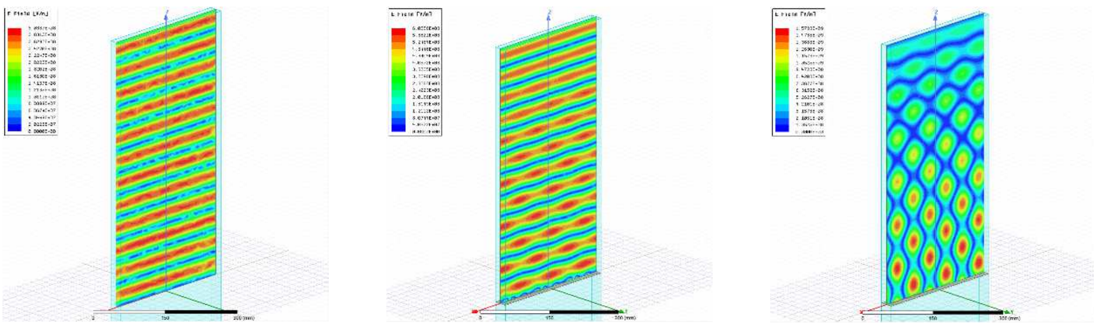

Figure 1. (a) Incident electric field only. **(b)** Incident and reflected electric fields during an initial time period. **(c)** Both fields at steady state. Although the frequency is fixed at 3.0 GHz, the reflected wavefront varies between (b) and (c) due to the presence of a waveform-selective metasurface with an improved dynamic range.

References

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