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Photonic Crystal Structures for High Frequency RF Sources[1]
GREGORY R. WERNER, University of Colorado, JOHN R. CARY, University of Colorado / Tech-X Corporation, Boulder, CO 80303 — As microwave frequencies rise through the GHz range, wavelengths decrease to millimeters and shorter. Because the simplest radio frequency (RF) sources rely on the interaction between electron beams and the lowest-frequency modes of cavities or waveguides, small RF structures must be used to produce high frequencies. Smaller RF sources require smaller beams, from which it is more difficult to extract high powers. To use larger beams, high-power sources often have larger RF structures operating at high-order resonances. Besides allowing larger beams, larger structures carry more power at a given maximum field intensity (limited by breakdown). Photonic crystals may facilitate the design of high-order-mode structures. Photonic crystals are periodic dielectric structures that can reflect electromagnetic waves within a narrow photonic band gap (PBG); photonic crystals can therefore trap and guide waves at frequencies within the band gap. Waveguides and cavities constructed from hollowed-out photonic crystals may be designed to limit the number of trapped modes; ideally, only a single high-order mode would be trapped, allowing construction of conceptually simple, high-power, high-frequency sources. Photonic crystal structures may also prove advantageous at frequencies beyond the GHz range where dielectrics can withstand higher fields than metal surfaces.

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