Advances in the Fabrication of 3-D Photonic Crystals Between the Optical and Mid IR Frequencies at Sandia National Laboratories

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Photonic crystals can serve as an excellent platform to enhance light-matter interaction in addition to providing enormous flexibility in the control of light propagation. However, few 3-D photonic crystals fabrication processes have demonstrated devices larger than one square centimeter. This severely limits industrial applications for such devices by restricting their use to local area photonic circuits instead of large optical platform materials. Sandia National Laboratories is currently developing several different process technologies capable of generating large area 3-D photonic band gap (PBG) materials for use in a variety of different optical and IR applications ranging from TPV technologies, optical lighting, or even large area IR filters for temperature control of space based vehicles.

The most mature scheme uses silicon MEMS lithographic fabrication means to create a mold which is filled by a novel tungsten deposition method. This technique is also used to generate silicon PBGs and can be tiled to create very large area arrays. A second method uses Deep X-ray Lithography (DXRL) and metal electrodeposition to create a mold in PMMA, which is filled by electro-deposition of gold, copper, or other materials to create woodpile and chiral PBGs. A third approach, nano-imprint technology, provides an inexpensive method for producing large areas of 3-D photonic band gap (PBG) materials for commercial applications. The combination of these procedures provides unique design capability for producing next generation PBG devices with band edges anywhere between 0.7 and 10 um.

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