Band-edge operation of two-dimensional photonic crystals with gain

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We present calculations of lasing action in microstructured systems embedded with a four-level gain medium. The Maxwell equations are coupled with the semi-classical laser equations and are self-consistently solved under a finite-difference time-domain scheme [1]. Our simulations show that a two dimensional photonic crystal (2DPC) operating near the band-edge can, in principal, lead to strong reduction of the lasing threshold with respect to a uniform gain slab of the same dimensions, in spite of the lower gain density. We demonstrate this fact with a 2DPC of as few as 10 layers and show how the lasing threshold is further reduced as the number of layers is increased. We also examine how the lasing threshold is affected by the band-edge proximity.

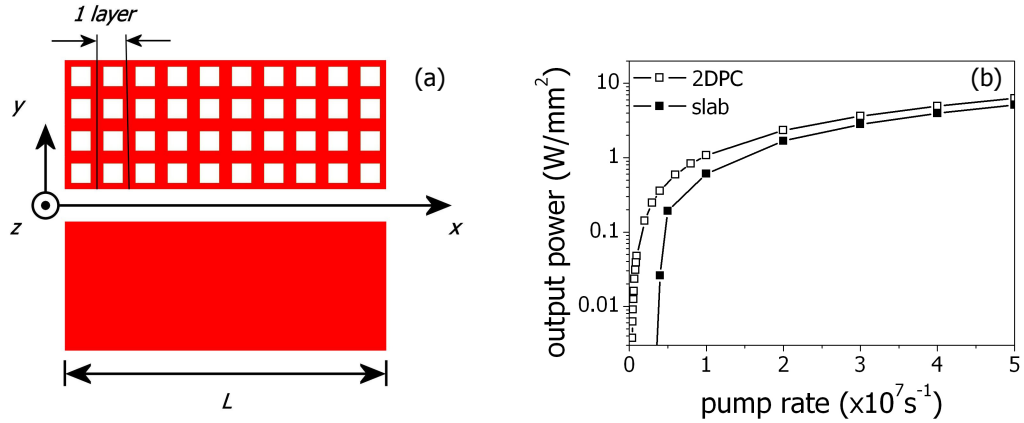

Figure 1: (a) Schematic of the 2DPC consisting of 10 layers (top) and the respective slab of uniform gain and same length (bottom). The red areas denote the host dielectric which is homogeneously embedded with the four-level gain material. Both systems are infinite in the *yz* plane and confined in the *x* direction, along which the emitted wave propagates. (b) Lasing power in log scale of the 2DPC (open squares) and gain slab (filled squares) as depicted in Figure 1(a) for different pump rates. Both systems operate at the frequency which corresponds to the bottom of the 2nd band of the 2DPC. The lasing threshold of the photonic crystal is 1 order of magnitude lower than that of the gain slab.

References

[1] A. Fang, T. Koschny and C.M. Soukoulis, J. Opt. **12**, 024013 (2010).

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