

The finite-difference time-domain modeling of bi-directional transmission spectra in thin 3-dimensional opal-based photonic crystals

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Understanding of the light scattering in finite size 3D PhCs in the regime of nearly ballistic light propagation is the ultimate demand for further development of functionalized 3D photonic crystals (PhC). In such PhC architectures a part of light propagates bi-directionally, e.g. before and after scattering at a defect. This scattered light can be used for characterization of artificial and intrinsic defects. Moreover, such light obeys symmetry selection-rule-free coupling to PhC eigenmodes and shows close similarity to propagation of spontaneously emitted light.

One particular practical method to model light propagation along arbitrarily chosen direction is the finite-difference time-domain technique. In this contribution we present a comprehensive numerical analysis of computation of bi-directional transmission spectra along arbitrary direction in opal-based PhCs. Comparison with experimental data obtained via scattering spectroscopy of thin opal films reveals excellent agreement in dispersion of transmission minima and angular distribution of the transmitted light magnitude. It proves that fine features of experimental transmission spectra like the anomalous red shift of the non-dispersive transmission minimum and angular range of the splitting between dispersive and non-dispersive minima can be picked up numerically too.