Absolute analytical prediction of photonic crystal guided mode resonance wavelengths -
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A class of photonic crystal resonant reflectors known as guided mode resonant filters are optical structures that are widely used in the field of refractive index sensing, particularly in biosensing. For the purposes of understanding and design, their behavior has traditionally been modeled numerically with methods such as rigorous coupled wave analysis. Here it is demonstrated how the absolute resonance wavelengths of such structures can be predicted by analytically modeling them as slab waveguides in which the propagation constant is determined by a phase matching condition. The model is experimentally verified to be capable of predicting the absolute resonance wavelengths to an accuracy of within 0.75 nm, as well as resonance wavelength shifts due to changes in cladding index within an accuracy of 0.45 nm across the visible wavelength regime in the case where material dispersion is taken into account. Furthermore, it is demonstrated that the model is valid beyond the limit of low grating modulation, for periodically discontinuous waveguide layers, high refractive index contrasts, and highly dispersive media.

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