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Review

Progress in 2D photonic crystal Fano resonance photonics

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Abstract

In contrast to a conventional symmetric Lorentzian resonance, Fano resonance is predominantly used to describe asymmetric-shaped resonances, which arise from the constructive and destructive interference of discrete resonance states with broadband continuum states. This phenomenon and the underlying mechanisms, being common and ubiquitous in many realms of physical sciences, can be found in a wide variety of nanophotonic structures and quantum systems, such as quantum dots, photonic crystals, plasmonics, and metamaterials. The asymmetric and steep dispersion of the Fano resonance profile promises applications for a wide range of photonic devices, such as optical filters, switches, sensors, broadband reflectors, lasers, detectors, slow-light and non-linear devices, etc. With advances in nanotechnology, impressive progress has been made in the emerging field of nanophotonic structures. One of the most attractive nanophotonic structures for integrated photonics is the two-dimensional photonic crystal slab (2D PCS), which can be integrated into a wide range of photonic devices. The objective of this manuscript is to provide an in depth review of the progress made in the general area of Fano resonance photonics, focusing on the photonic devices based on 2D PCS structures. General discussions are provided on the origins and characteristics of Fano resonances in 2D PCSs. A nanomembrane transfer printing fabrication technique is also reviewed, which is critical for the heterogeneous integrated Fano resonance photonics. The majority of the remaining sections review progress made on various photonic devices and structures, such as high quality factor filters, membrane reflectors, membrane lasers, detectors and sensors, as well as structures and

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phenomena related to Fano resonance slow light effect, nonlinearity, and optical forces in coupled PCSs. It is expected that further advances in the field will lead to more significant advances towards 3D integrated photonics, flat optics, and flexible optoelectronics, with lasting impact in areas ranging from computing, communications, to sensing and imaging systems.

Keywords: Fano resonances; Photonic crystals; Membrane lasers; Filters; Slow light; Silicon photonics

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