Demonstration of a self-pulsing photonic crystal Fano laser

The semiconductor lasers in use today rely on various types of cavity, making use of Fresnel reflection at a cleaved facet, total internal reflection between two different median, Bragg reflection from a periodic stack of layers, mode coupling in a high contrast grating or random scattering in a disordered medium. Here, we demonstrate an ultrasmall laser with a mirror, which is based on Fano interference between a continuum of waveguide modes and the discrete resonance of a nanocavity. The rich physics of Fano resonances has recently been explored in a number of different photonic and plasmonic systems. The Fano resonance leads to unique laser characteristics. In particular, because the Fano mirror is very narrowband compared to conventional laser mirrors, the laser is single mode and can be modulated via the mirror. We show, experimentally and theoretically, that nonlinearities in the mirror may even promote the generation of a self-sustained train of pulses at gigahertz frequencies, an effect that has previously been observed only in macroscopic lasers. Such a source is of interest for a number of applications within integrated photonics.