Iterative strategies for the structural design of nanophotonic components

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We present first results of two ongoing studies, which explore the capability of inherent quantities such as the optically induced force (exerted on the device boundary) or the device's optical near field to serve as "natural strategies" in an iterative structural optimization scenario.

As a first approach an iterative "force strategy" is used for shaping a two-dimensional (2D) simply-connected photonic microcavity towards a maximum quality factor *Q*. Figure 1 shows an evolving particle that is illuminated by a TM-polarized plane wave at the particle's resonance. By applying the inverted time-averaged optical force on the particle's surface [1], a "natural" strategy for energy maximization is achieved.

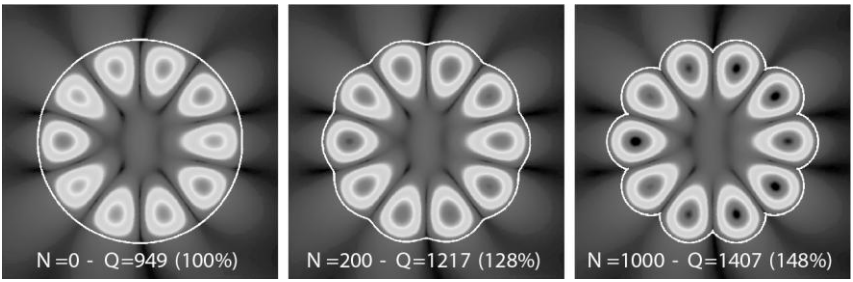

Figure 1: Simulated magnetic field distribution (|Hz|) within an evolving 2D dielectric micropillar (r = 667 nm, ε_r = 10, embedded in air) at three different iteration stages N. The structure is excited by a plane wave from the left at a resonance wavelength of 1550 nm.

Within a preliminary study we further developed an idea proposed by Naruse et al. [2], where optical nearfields at boundary edges are iteratively applied to a generic photosensitive patterning procedure in order to achieve sub-wavelength structure formation. The inquiry is driven by the question of whether predefined nano-patterning is feasible in the sense of an inverse problem solution.

[1] T. Liebig, and D. Erni, "Using optically induced forces in numerical structural optimization," *XVII Int. Workshop on Optical Waveguide Theory and Numerical Modeling (OWTNM 2008)*, June 13-14, pp. 36, PO-14, Eindhoven, The Netherlands, 2008.

[2] M. Naruse, T. Yatusi, K. Kitamura and M. Ohtsu, "Generating small-scale structures from large-scale ones via near-field interactions," *Opt. Express*, vol. 15, no. 19, pp. 11790-11797, Sept. 17, 2007