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On-chip Fabry-Perot microcavity arrays for cavity QED (I)

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We describe a monolithic thin-film buckling process used to fabricate arrays of high-finesse, tunable, curved-mirror Fabry-Perot cavities on a chip. Arrays of small-mode-volume cavities exhibit good uniformity and nearly reflectance-limited finesse. The process has been adapted to a variety of thin film material combinations, for operation throughout the visible and near-infrared regions. Ongoing efforts to integrate gas-phase, liquid-phase and solid-state light emitters, and to integrate cavity resonance tuning mechanisms, will also be described.
For cavity QED applications, these cavities offer an intriguing mix of potential advantages. Their monolithic fabrication by buckling self-assembly results in smoothly curved mirrors forming a 'self-aligned'cavity with highly predictable Gaussian mode properties. Furthermore, the cavities have a hollow core which is effectively enclosed by upper and lower Bragg mirrors. This can lead to significant inhibition of background emission for emitters embedded within the air core, particularly if the Bragg mirrors have sufficiently high index contrast to provide an omnidirectional reflection band. Preliminary results from a theoretical study of dipole emission inside cavities with Si/SiO2-based omnidirectional Bragg mirrors will be presented. Using parameters extracted from previously fabricated cavities (operating in a fundamental spatial mode regime at ˜ 1550 nm with modest Q ˜2000 and low mode volume on the order of one cubic wavelength), and an optimally located emitter, we predict simultaneous Purcell enhancement of emission into the cavity mode by ˜120 and suppression of background emission by ˜25. These results imply a potential for high cooperativity and a near-unity spontaneous emission coupling factor, even for a relatively broad line-width emitter.

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