Coding two dimensional patterns into mode spectrum of silicon microcavity covered with a phase-change film

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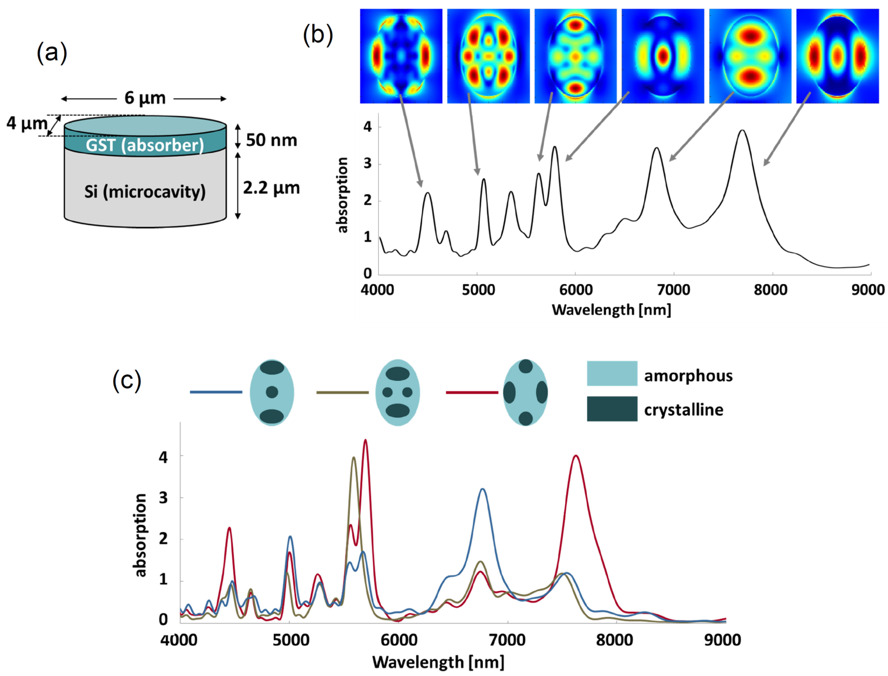
ABSTRACT

Coding images or spatial structures into a lower dimensional signal space is the most critical process in terms of time, costs and energy efficiency in intelligent information processing, including machine learning and artificial intelligence. In this study we propose a method to encode a two-dimensional subwavelength pattern (image) into the infrared optical spectrum. A silicon microcavity is used to generate light confinement modes with a variety of field distributions and a wide range of resonant peaks. An amorphous phase-change film, which covers the microcavity, memorizes the two-dimensional pattern projected on the surface of microcavity by allowing partial crystallization and thus modifies the optical spectrum due to the change in refractive index of the phase-change film.

Figure 1(a) shows a model of silicon microcavity/ phase-change film (GeSbTe; GST) for numerical simulation of light confinement and its modification upon phase change. Resonant peaks due to light confinement in the microcavity distribute in a wide range of absorption spectrum down to infrared (Fig. 1(b)). The electric field distributions at the surface of microcavity (inside of the GST film) for individual confinement mode are also visualized. Figure 1(c) illustrates how the absorption spectrum is modified through the partial crystallization of amorphous GST film for three different patterns. Depending on the degree of matching of the pattern with field distribution of confinement modes, distinct differences in spectrum modification are confirmed, which demonstrates the possibility for encoding device application.



Key words: Light confinement, microcavity, cavity modes, sparse coding.