Nano-fabrication techniques for near-field photonic crystals

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Abstract -- In this paper, we demonstrate a unique technique of fabricating two-dimensional nano-structures for photonic crystals under evanescent field. The new technique is based on a novel near-field probe-scanning total internal reflection (STIR) microscope.

Since last decade, there is a pressing need to develop photonic crystals technology for ultrafast/ultrawide telecommunication. Photonic crystals are periodic structures, which has the characteristic features to manipulate light propagation due to their photonic bandgap for a certain wavelength range. This unique characteristic feature makes photonic crystals a key component in integrated optical circuitry (IOC). Photonic crystals can has periodic structures in one, two and three dimensions, respectively called one-dimensional (1-D), two-dimensional (2-D) and three-dimensional (3-D) photonic crystals.

In this paper, we focus on the fabrication techniques for 2-D photonic crystals, partly because the photonic bandgap effect is easier to achieve in 2-D photonic crystals compared with 3-D photonic crystals, which makes 2-D photonic crystals the right candidate for coupling light into a 3-D IOC. One of the key techniques used for fabrication 2-D photonic crystals is the photo-polymerization technique. Photo-polymerization can take place either under far-field illumination and near-field illumination. Although photo-polymerization under evanescent wave gives the advantage of depth control at sub-micrometer level, the apparent disadvantage for evanescent illumination is its weak field strength. In order to overcome this problem, we introduce a fabrication technique which is based on a novel near-field probe -- scanning total internal reflection (STIR) microscopy (Fig.1). With STIRM, evanescent wave is greatly enhanced due to the tight focus of a high numerical aperture objective lens (NA=1.65), therefore single-photon (1-p) and two photon (2-P) photo-polymerization can be achieved under evanescent wave illumination.

Fig.1 Schematic diagram of a new fabrication probe based on a scanning total internal reflection microscope

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