Laser Nanoimprinting Technique

for a Large Area Surface Nanostructuring

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The laser nanoimprinting method makes use of laser irradiation through a transparent mask, microlens array to generate patterns over a large area in a short time. The tiny microlenses focus a laser beam to up to millions of focal points, which act as light "pens" to "write" arbitrary features efficiently. Compared with other patterning methods, the laser nanoimprinting technique has the advantages of high-efficiency, high-output, low-cost, non-contact, and flexible environmental requirement. Different laser sources, such as femtosecond laser (wavelength of 800 nm) and excimer laser (wavelength of 248 nm), are used for patterning in phase-change and photoresist films.

Phase-change films have two phase states, amorphous and crystalline, which transform to each other by heat treatment. By placing the phase-change films at the focal plane of the microlens array, uniform laser-induced crystalline features can be fabricated quickly. Near-field scanning optical microscopy, electrical force microscopy, and atomic force microscopy are used to characterize optical & electrical properties and morphology of the patterned phase-change films. Due to the ultrashort pulse duration of the femtosecond laser, patterns down to around 50 nm feature size, are observed in the phase-change films by irradiation with proper laser power. By using excimer laser nanoimprinting method, feature sizes of about 80 nm can be obtained in a photoresist layer, which implies a high resolution of around $\lambda/3$. Such small feature size shows that it is possible for the laser nanoimprinting technique to overcome the optical diffraction limit for a large area surface nanostructuring.