Nanoimprint Technology and Applications

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Nanoimprint technology is a new fabrication method to fabricate nano-scale patterns. Fine patterns are formed on a polymer film by pressing a nano-mold that has fine concavity and convexity patterns on the surface. The application fields are spreading to IT-electronics, bio-life science and energy-environmental devices. Principal of nanoimprint and some examples of application will be reported.

Keywords: nanoimprint, nanoprnt, nanopillar

1. Introduction

Nanoimprint technology is attractive to fabricate nano-scale patterns [1]. There are several types of nanoimprint, such as thermal imprint or photo-cure imprint [2]. In this report, basic process and some application are briefly reported.

2. Principle

The nanoimprint process is shown in Fig. 1. The polymer film is coated on a substrate, and the nano-mold is pressed onto the polymer film. Thermal and photo-cure imprint use thermoplastic and photo-curable polymer, respectively. After pressing and solidification of polymer, the nano-mold is released from the polymer. The fine patterns are formed on the polymer film.

formed polymer film functions as the device. Therefore the polymer material must be designed considering the functionality of device. For example, in case of immunoassay chip, the antigen-antibody reaction is controlled on the chip surface so that the polymer material should be considered the characteristics of chemical absorption.

The polymer deformation becomes unique when the deformation scale is the same scale of molecule. Fig. 2 shows the high aspect ratio nanopillar structure that is obtained by polymer elongation. The depth of the hole on the nano-mold is 1 μm but the height of the nanopillars is 3 μm . This phenomenon was controlled by the polymer properties and anti-adhesion treatment on the nano-mold.

Fig. 1 Process sequence of nanoimprint.

In case of lithography, the patterned polymer film functions as a resist for etching process of the substrate. In general, the polymer films are removed during the device fabrication processes. Therefore, the material designs are mainly focused on an etching durability, resolution and so on. On the other hand, in case of the bio devices, the

Fig. 2 Example of nanopillar structure.

Fig. 3 Imprinted fine patterns on the disk.

3. Applications

It is easy to embed the nano or micron-scale structures to the conventional or new devices by using the nanoimprint technology. Here, some examples are briefly introduced.

3.1 IT, electronics devices

The final goal of this field seems to be LSI production. However, there are many technical barriers to produce LSI by nanoimprint, such as alignment or yield. Recent topic is application for storage media.

Fig. 3 shows the example of imprints patterns for patterned media. The storage tracks or bits are spatially separated by disk etching. It becomes very difficult to fabricate the etching pattern in a whole disk by conventional electron beam (EB) lithography because of low throughput of EB machine. Nanoimprint is attractive because once after making the nano-mold, it is easy to replicate the same patterns on the whole disk at a time. The lines or dots function as recording tracks or storage bits. These kinds of discrete media are eager to achieve for tera-bit age [3].

Fig. 4 Fluorescence intensity from the immunoassay nano-chip.

3.2 Bio-life science

There seems much application in bio-life science field because the sizes of cells, DNAs or macromolecules are comparable that of the pattern sizes formed by nanoimprint. Fig. 4 shows the fluorescent image of immunoassay chip after antigen-antibody reaction of AFP (alpha feto-protein). The surface area is increased from right to left in the chip by reducing the nanopillar diameters. The strong fluorescence intensities were observed from nano-structured areas. This indicates that nanopillar structure is attractive for high sensitive immunoassay chip [4].

References

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