

NANOLITHOGRAPHY USING SELF-ASSEMBLED BLOCK COPOLYMER AND APPLICATION TO ELECTRONIC DEVICES

Koji Asakawa, Kaori Kimura, Hiroyuki Hieda, Masatoshi Sakurai, Yoshiyuki Kamata, Akira Fujimoto, Toshiro Hiraoka, Akira Kikitsu, Katsuyuki Naito

Corporate R&D Center, Toshiba Corporation, Kawasaki 212-8582, Japan

kouji.asakawa@toshiba.co.jp

The performance of electronic parts greatly improves as feature sizes become smaller. Less expensive nano-fabrication technology is desirable for various types of electronic devices.

Block copolymers are known to form nano-scale microdomains by microphase-separation. When it is cast on a substrate and annealed, nano-scale periodic patterns are obtained and a substrate can be fabricated using the pattern as an etch mask.¹ Block copolymers consisting of an aromatic polymer and an acrylic polymer showed a big difference in the dry-etch resistance between two polymers where one component was selectively removed by reactive-ion etching (RIE): a widely used method in semiconductor manufacturing processes. As continuing RIE, the nano-scale periodic block copolymer pattern was transferred on the substrate.²

Regarding the application of this method, the world's first circumferential patterned media for a hard disk drive (HDD) was demonstrated.³ The submicron grooves were engraved by nanoimprint and the microdomains of the block copolymer were aligned inside the grooves. The fine aligned nano-scale magnetic particles were fabricated on a 2.5-inch diameter glass plate as shown in figure 1.

Another application derived from this method is fabricating a nano-columnar structure on the emitting surface of a light emitting diode (LED) to increase its light-extraction efficiency.⁴ The light-extraction efficiency was more than doubled and a high luminescent LED was realized as shown in figure 2. This method can be applied to various kinds of optical devices.

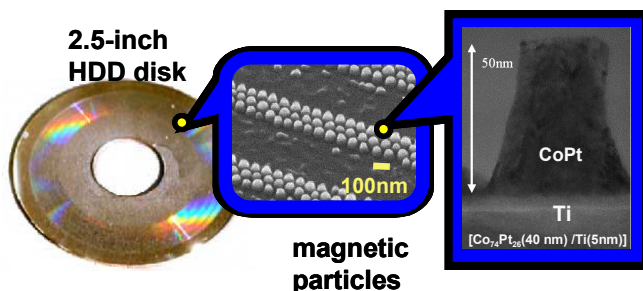


Fig.1 Patterned magnetic media for HDD

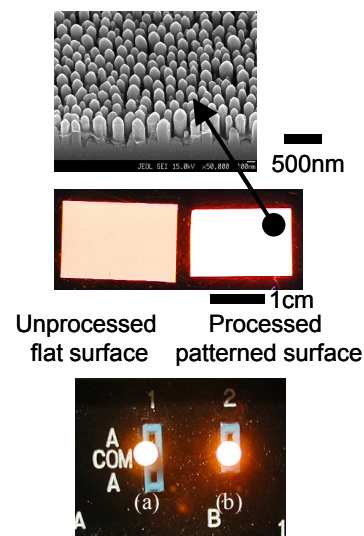


Fig.2 High luminescent LED

References

1. M. Park, C. Harrison, P. M. Chaikin, R. A. Register, D. H. Adamson, *Science* **276**, 1401 (1997).
2. K. Asakawa, T. Hiraoka, *Jpn. J. Appl. Phys.* **41**, 6112 (2002).
3. N. Naito, H. Hieda, M. Sakurai, Y. Kamata, K. Asakawa, *IEEE Trans. Magn.* **38**, 1949 (2002).
4. K. Asakawa, A. Fujimoto, *Appl. Optics*, **44**, 7475 (2005).

This paper partially belongs to "Terabyte optical storage technology" project, which OITDA contracted with the ministry of economy trade and industry of Japan (METI) in 2002 and the new energy and industrial technology development organization (NEDO) since 2003 based on funds provided from METI. This work was also supported by the IT-program (RR2002) of the ministry of education, culture, sports, science and technology (MEXT), Japan.