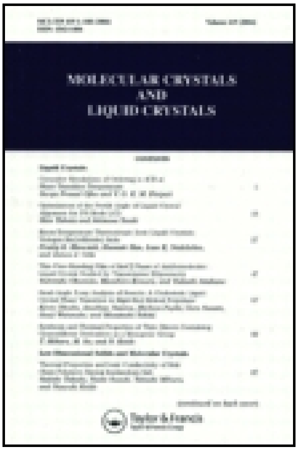

Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

Optical Microstructure of CuPc Thin Film Prepared by Thermal Evaporation

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Version of record first published: 24 Sep 2006

Mol. Cryst. and Liq. Cryst., 2001, Vol. 371, pp. 247-251

Optical Microstructure of CuPc Thin Film Prepared by Thermal Evaporation

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The α-type CuPc thin film prepared by thermal evaporation has the b-axes parallel to the substrate plane. We report the comparison of the optical structure and the height image of CuPc layer deposited on Si surface using the Near-field solid immersion lens (NSIL) and a contact AFM. The optical microstructure of CuPc surface was measured by focusing a laser beam(λ=442 nm) in a solid immersion lens(SIL).

Keywords: AFM, NSIL, optical microstructure, CuPc film

INTRODUCTION

Since Near-field solid immersion lens (NSIL) detects the optical

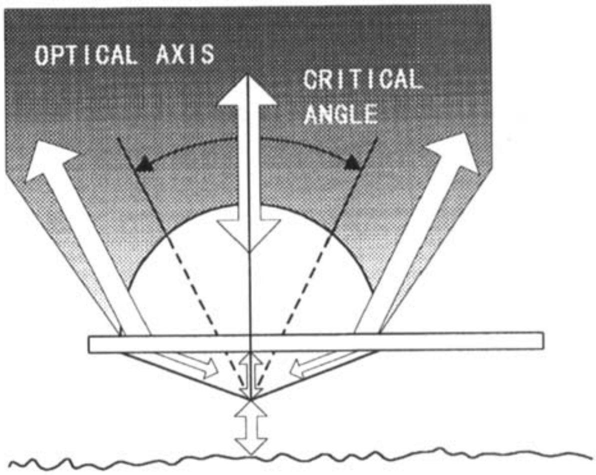

FIGURE 1. Schematic of the SIL showing light incident along the optical axis transmitted to the sample surface and light incident above the critical angle the is totally internally reflected.

properties with high resolution, NSIL can observe the molecular aggregation structure, which cannot be investigated by other techniques[1,2]. The SIL have an advantage of the high optical transmission efficiency, about three orders of magnitude greater than the pinhole of fiber-based near-field microscopes. That is, the SIL can both focus the illumination and efficiently collect light to image the transparent and reflecting samples.

The operating principle of the SIL shows the schematic diagram in Figure 1. Now consider light traveling along the optical axis and incident below the critical angle. The light enters the SIL, there is a reflection from the SIL tip and transmission across the air gap to the sample surface. Some of light reflected from the sample returns to the SIL where it can interface with the reflection from the SIL tip. Upon entering the SIL, these rays converge to a small spot at the tip and are totally internally reflected. There is no transmission to the sample surface, but there is an evanescent field outside the SIL that decays exponentially over a distance less than 100 nm. Thus, high-resolution optical imaging is possible when the gap between the SIL and sample is less than evanescent field decay length.

In this study, we report the optical microstructure of copper phthalocyanine(CuPc) thin film by the contact AFM image and the NSIL image was measured by the NSIL and AFM image. CuPc has been extensively studied for semiconductive and photoconductive properties. Especially the α-type CuPc has a large photo-absorption coefficient in the visible region. CuPc surface was measured by focusing a laser beam(λ=442 nm) in a solid immersion lens(SIL) that is mounted on a flexible cantilever and scanned by AFM.

EXPERIMENTAL

CuPc thin film is fabricated using thermal evaporation (1×10^{-6} torr). The growth rate is 0.1 $nmsec^{-1}$. CuPc powder was purified by vacuum -

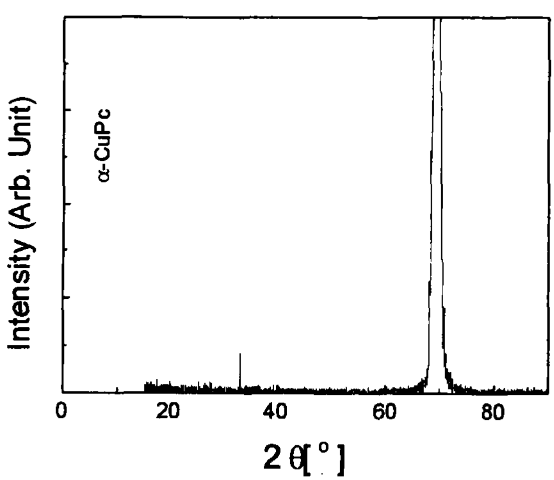

FIGURE 2. XRD patterns of a CuPc thin film on Si(100).

system ($1x10^{-4}$ torr). The crystallization and the orientation of CuPc thin film have been investigated by XRD. The topographic surface structure of CuPc layer was observed with an AFMunder contact mode. The optical surface structure was carried outwith polarized Near-field solid immersion lens (NSIL). The NSILimage was taken with 442 nm illumination from a He:Cd laser in a solid immersion lens(SIL) that is mounted on a flexible cantilever and scanned by AFM.

RESULTS AND DISCUSSION

Figure 2 shows the XRD patterns of a CuPc thin film on Si substrate. The substrate temperature was 300 °C. The XRD patterns prepared at a growth of 0.1 nm/sec exhibited one peak at the 12.95 Å spacing of the α-CuPc (200) planes.

Figure 3 shows a contact AFM and the NSIL image of CuPc layer. The topographic image shown in Figure 3(a) is composed of large

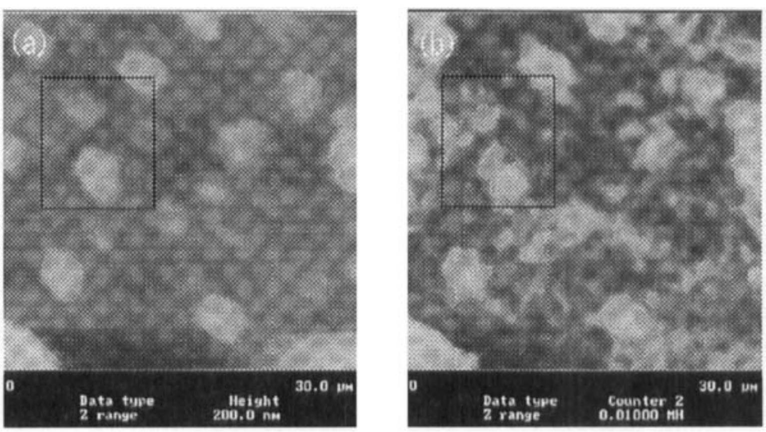

FIGURE 3. 30 µm x 30 µm image of CuPc layer: (a) Contact AFM and (b) NSIL image of CuPc layer. The images are taken at the same area, data scale 200 nm and 0.01 MHz.

round grains and a flat matrix. The optical image in Figure 3(b) demonstrates small white and dark spots that appears the same areas. The size crystals were not uniform. This result clearly suggests that the optical structure generates by an excite luminescence.

In conclusion, we have observed the images of the contact AFM and the near-field optical microscopy. From the comparison with the contact AFM image by a dashed square, the NSIL image is much more complicated than the topographic image. Small bright and dark spots can be observed at the center of the spheres of the topographic. There is a correspondence between the AFM and SIL images for features below the diffraction limit. This image suggests that optical interference contrast measure surface topography.

References

[1] L.P.Ghislain and V.B.Elings, App.Phys.Lett. **72**, 2779(1998)

[2] L.P.Ghislain and V.B.Elings, K.B.Crozier, S.R.Manalis, S.C.Minne, K.Wilder, G.S.Kino and C.F.Quate, Appl.Phys.Lett. **74**, 501(1999)