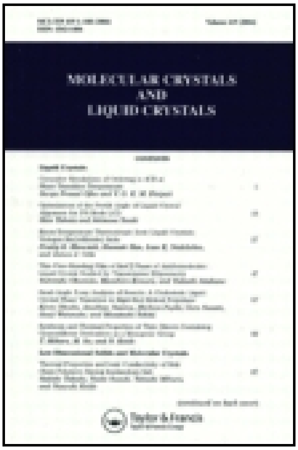



Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

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

# Development and Application of a Direct Beam Lithography for the Bioelectronic Device

Jeong-Woo Choi [a], Yun-Suk Nam [a], Se-Yong Oh [a], Dongho Kim [b] & Won Hong Lee [a]

[a] Dept. of Chem. Eng., Sogang Univ., C.P.O. BOX 1142, Seoul, 100-611, Korea

[b] National Creative Research Initiatives Center for Ultrafast Optical Properties Characterization, Korea Research Institute of Standards and Science, P.O. BOX 102, Yusong, Taejeon, 305-600, Korea

Version of record first published: 24 Sep 2006

*Mol. Cryst. and Liq. Cryst.*, 2000, Vol. 349, pp. 295-298
Reprints available directly from the publisher
Photocopying permitted by license only



# Development and Application of a Direct Beam Lithography for the Bioelectronic Device

JEONG-WOO CHOI[a], YUN-SUK NAM[a], SE-YONG OH[a], DONGHO KIM[b] and WON HONG LEE[a]

[a]*Dept. of Chem. Eng., Sogang Univ., C.P.O. BOX 1142, Seoul 100–611, Korea and* [b]*National Creative Research Initiatives Center for Ultrafast Optical Properties Characterization, Korea Research Institute of Standards and Science, P.O. BOX 102, Yusong, Taejeon 305–600, Korea*



Direct beam patterning on metal/protein/organic material coated ITO substrates is investigated using laser light for submicron scale lithography. A laser writing lithography method is developed using the 400nm Ti:Sapphire laser. Using a microscope objective lens, a laser beam is focused onto a glass slide coated with metal/protein/organic material film. Localized laser absorption results in partial melting and ablation of film. Spatially moving the laser spot, a stable etched pattern is obtained at submicron resolution. This result opens many possibilities for microfabrication of bioelectronic devices.

*Keywords:* direct beam lithography; laser; bioelectronic device

## INTRODUCTION

Lithographic methods are at the heart of modern-day microfabrication, nanotechnology and molecular bioelectronic device[1]. The method of direct beam lithography at a submicron scale has been developed. It can be used to create patterns on bioelectronic device surface. This method has simple but powerful tool for direct pattering on metal/protein/organic material film surface compared with another patterning method because the easy handling, high resolution and no wholly heating.

In this study, the metal/insulator/metal (MIM) structured bioelectronic device using green fluorescence protein(GFP) /viologen film is constructed. The direct beam patterning on MIM structured device is investigated for the submicron scale lithography.

## EXPERIMENTAL DETAILS

Two kinds of materials were used. Recombinant Green Fluorescent Protein(rEGFP, CLONTECH, USA) and N-Allyl-N'-[3-propylamido-N",N"-di(n-octadecyl)]-4, 4'-bipyridium dibromide (viologen), were used as a functional protein and organic molecule.

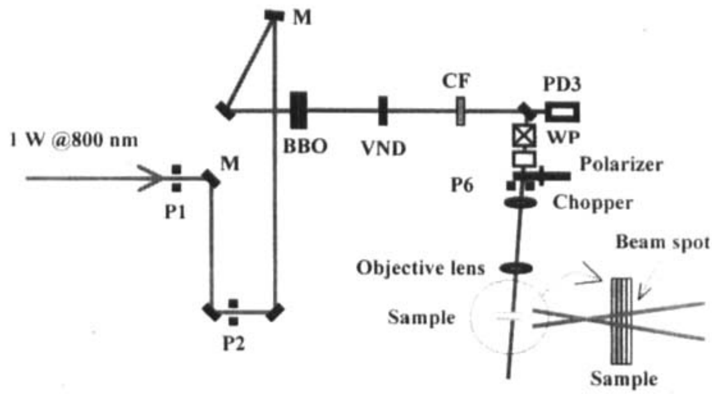


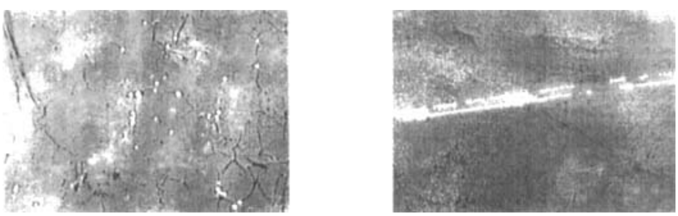

FIGURE 1.Schematic illustration of direct beam lithography system

The deposition of LB film was carried out using a circular Langmuir trough (Type 2022, Nima Tech., England). The substrate (bottom electrode) was ITO coated glass. 11 layers viologen were deposited onto the substrate by LB method and GFP were adsorbed onto the surface of viologen layers, sequentially. Top electrode was vacuum evaporated aluminum. Thus the MIM structured device was constructed. A direct beam patterning system consisting of a self-mode-locked femtosecond Ti:Sapphire laser (Clark MXR. NJA-5), a Ti:Sapphire regenerative amplifier (Clark MXR, CPA-1000) pumped by a Q-switched Nd:YAG laser (ORC-1000), a pulse stretcher/compressor, OPG-OPA system. A femtosecond Ti:sapphire oscillator pumped by a CW Nd:YVO3 laser (Spectra physics, Millenia) produces a train of 60fs mode-locked pulses with an averaged power of 250mW at 800nm. The seed pulses from the oscillator were stretched (~250ps) and sent to a Ti:sapphire regenerative amplifier pumped by a Q-switched Nd:YAG laser operating at 1kHz. The wavelength of laser pulse through the BBO crystal has 400nm. Fig.1 shows the experimental setup of direct patterning system. The laser beam is focused to a spot on the MIM film surface using a microscope objective lens. Laser absorption results in local melting and ablation of the MIM film. The patterned surface was observed using optical microscope and Atomic Force Microscope (Autoprobe CP, PSI USA).



## RESULTS AND DISCUSSION

Figure 2 shows the surface image of patterned surface using an optical microscope of 400 magnification. Direct beam lithography has been performed with ca.0.5~1μm resolution trace leaves on the surface of proposed device.



(a) (b)

FIGURE 2. Optical microscopy image(× 400): a, spot ablation; b, patterned trace

White dot and white line indicates the patterned trace. The patterned point of MIM film surface observed with 1μm resolution ablation and the permanent trace line observed with 1μm width. The trace line was formed to irregular. The patterned line trace was shown in Fig 3 using AFM with 5μm scale. The patterned line has 0.8nm depth and 1μm width. The ablation surface showed irregular and rarely cut off of patterned trace but the beam traces were shown in clearly and depth was almost uniformly. It was also observed that the Al/GFP/viologen hetero film does not form a uniform layer but a grainy pattern, with some areas more densely covered.

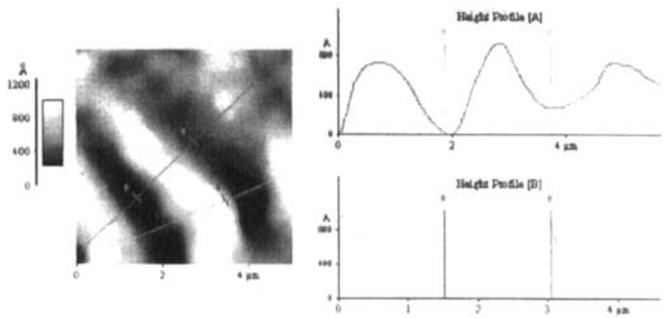



FIGURE 3. AFM image of patterned line trace with 5μm scale: a, surface morphology; b, height analysis of AFM image

Direct beam lithography on the metal/protein/organic film surface has been successfully done. This result opens the way to fabricate the molecular scale bioelectronic device.

**Acknoldgement**

This work was supported by grants from the Korea Ministry of Science and Technology (98-NF-02-07-A-01) and National Creative Research Initiatives of Ministry of Science and Technology.

## *References*

[1] G. V. Shivashankar and A. Libchaber, *Applied Physics Letters,* **73,** 417 (1998).