Microplasma Device Utilizing SU-8 Photoresist as a Barrier Rib

Sung-O Kim, *Member, IEEE*

Abstract—**A Microplasma device utilizing SU-8 photoresist as a barrier rib has been fabricated and characterized operating in the abnormal mode for neon pressures from 300 to 800 torr and having a hexagonal structure, 5 × 5 arrays of microplasma. The microplasma device, which has a simple fabrication process, offers advantages such as low firing voltage, low cost, and stable glow discharge. The electrical properties have been examined by bipolar voltage waveforms with different frequencies. The geometric patterns of the barrier rib can be simply changed by lithographic techniques.**

Index Terms—**Microdischarge.**

MUCH OF THE interest in microplasma devices stems from generating efficient vacuum ultraviolet to visible radiation. There are many valuable applications such as liquid crystal display backlighting, plasma display panels, environmental sensors, and lighting systems. Unfortunately, current microplasma devices have revealed that dimensional control cannot be kept consistently accurate by the drilling method [1]–[5]. Such a process is not feasible for large arrays with stable glow discharges. Recently, semiconductor fabrication technology has been used for low cost arrays.

In this paper, we suggest a process to improve microplasma arrays with photodefinable glass. We utilize SU-8 photoresist as a barrier rib to fabricate the microplasma device. This technology affords the opportunity to realize any geometric and high resolution patterns by lithographic techniques. Therefore, it is desirable for many applications requiring a pixel source for spatial resolution and characteristic.

Fig. 1 shows the schematic diagram of the microplasma device structure used in this study. The Si wafer, as a substrate, has a 1-μm thermal oxide as a buffer layer. The Cr electrode is fabricated on the SiO_2 by the liftoff process. The width of the gap between each electrode is 20 μm. The thickness and width of the Cr electrode are 1000 Å and 15 μm, respectively.

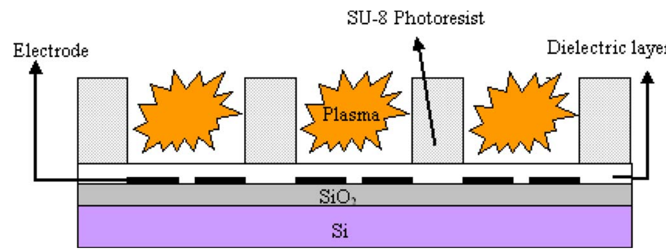

Fig. 1. Schematic diagram of the microplasma device.

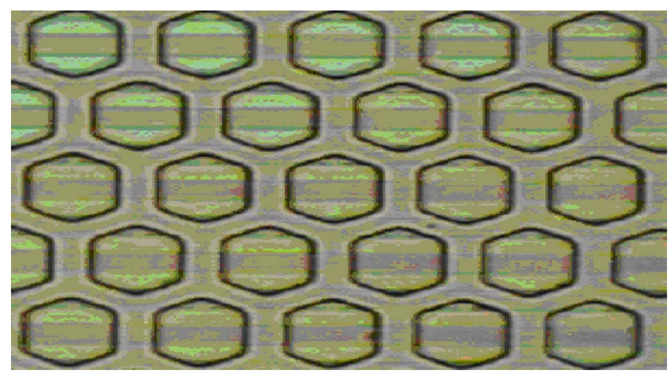

Fig. 2. Photograph of the 5 × 5 arrays of the microplasma device with a hexagonal structure.

After depositing a dielectric layer (HfO_2) by an E-gun evaporator, the photoresist serving as a barrier rib is made on the dielectric layer. The SU-8 is spun on the substrate, and the geometric pattern is realized by the lithographic techniques. The vacuum chamber is pumped down to 2×10^{-6} torr by a turbomolecular pump and is backfilled with the neon gas between 300 and 800 torr. The bipolar voltage waveform with different frequencies is applied between the Cr electrodes by a pulse dc power controller (SPIK 2000A, ShenChang Electric Co., Ltd.). The fabricated device, shown in Fig. 2, is investigated in a vacuum chamber. Photographs of the microplasma device and glow are captured by an optical measurement system (Navitar, Inc.). The glow of the 5 × 5 arrays, shown in Fig. 3, is uniform and operating 300 torr. The driving voltage and frequency are 250 V and 10 kHz, respectively. After operating the microplasma device, the barrier rib is still well-found. The microplasma device exhibits an abnormal glow discharge and has low firing voltage with bipolar pulse. The firing voltage can be reduced by increasing the neon pressure.

Manuscript received September 19, 2007; revised February 6, 2008. This work was supported in part by the Ministry of Economic Affairs Technology Development Program for Academia under Contract 96-EC-17-07-S1-046, by the National Science Council under Contract NSC96-2221-E009-079-MY3 in the Republic of China, and by the Semiconductor Research Corporation.

S.-O. Kim is with the Department of Photonics and Display Institute, National Chiao Tung University, Hsinchu 300, Taiwan, R.O.C.

Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.

Digital Object Identifier 10.1109/TPS.2008.922939

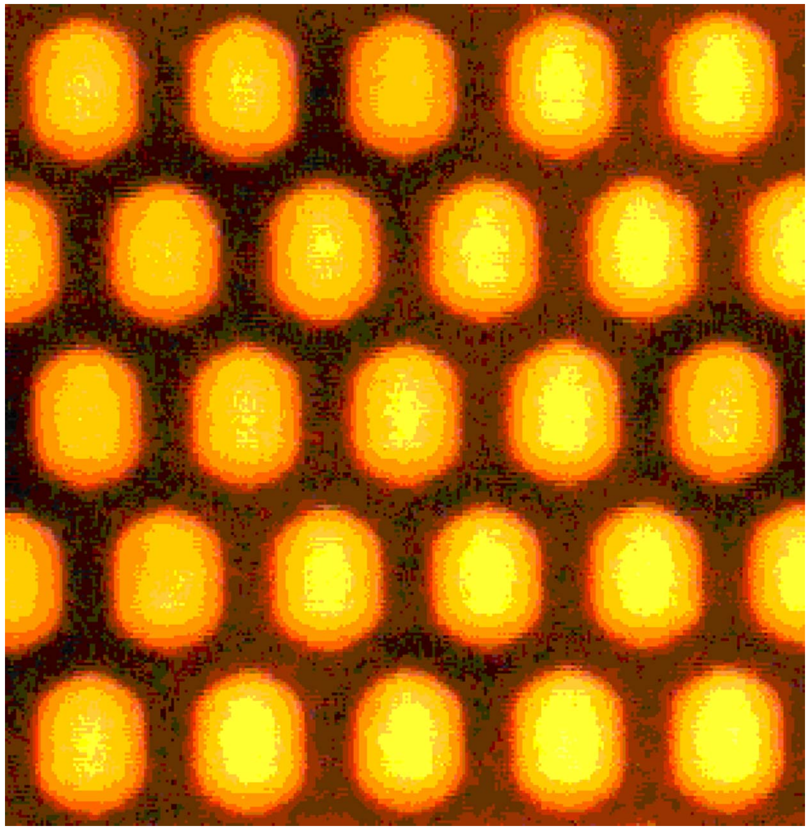

Fig. 3. Photograph of the 5 × 5 arrays of the microplasma device with a hexagonal structure operating 300 torr of neon gas.

References

[1] K. H. Schoenbach, R. Verhappen, T. Tessnow, F. E. Peterkin, and W. W. Byszewski, "Microhollow cathode discharges," *Appl. Phys. Lett.*, vol. 68, no. 1, pp. 13–15, Jan. 1996.

[2] J. W. Frame, P. C. John, T. A. DeTemple, and J. G. Eden, "Continuous-wave emission in the ultraviolet from diatomic excimers in a microdischarge," *Appl. Phys. Lett.*, vol. 72, no. 21, pp. 2634–2636, May 1998.

[3] J. W. Frame and J. G. Eden, "Planar microdischarge arrays," *Electron. Lett.*, vol. 34, no. 15, pp. 1529–1531, Jul. 1998.

[4] S.-O. Kim and J. G. Eden, "Arrays of microplasma devices fabricated in photodefinable glass and excited AC or DC by interdigitated electrodes," *IEEE Photon. Technol. Lett.*, vol. 17, no. 7, pp. 1543–1545, Jul. 2005.

[5] S.-O. Kim and J. G. Eden, "Arrays of square cross-section microdischarge devices fabricated in glass and driven by interdigitated electrodes," *IEEE Trans. Plasma Sci.*, vol. 33, no. 2, pp. 566–567, Apr. 2005.