B－4－8 A Proposed Novel Amorphous-Silicon Image Sensor

Hiroshi Hayama, Yasuo Nara, Kohichiro Ishibashi and Masakiyo Matsumura

Department of Physical Electronics, Tokyo Institute of Technology

Meguro-ku, Tokyo, Japan

Recently,many attentions have been paid for amorphous-silicon (a-Si) films prepared by glow-discharge decomposition of silane because they exhibit electrical and optical properties that are similar to those of crystalline semiconductors. In this paper, we propose and verify experimentally a novel a-Si image sensor, which utilizes the high performance of a-Si thin film FET[1,2], high photo-conductivity of a-Si and high dark-resistivity of a-Si.

Figure 1 shows a unit cell structure of a proposed image sensor. The cell consists of an a-Si FET, an a-Si photo-conductor and an MOS capacitor. Fabrication procedures were described elsewhere.[2] While the evaporated aluminum is etched off from the active n^- a-Si of the photo-conductor, the aluminum is remained on the active n^- a-Si of the FET, acts as a gate electrode and stops the incident light. The equivalent circuit becomes as shown in Fig.2. This device operates as follows: while the FET is off the current which flows through the photo-conductor is accumulated in the capacitor, and when the FET turns on, these accumulated charges are discharged instantaneously. When CR time constant of the capacitace and dark-resistance of the photo-conductor is much longer than a period of clock pulse, amplitude of current packet passing through the FET is propotional to the intensity of illumination. Thus, by application of clock pulse train to the cell-array successively, we can pick-up one-dimensional or two-dimensional image.

Figure 3 shows a photograph of the prototype 8-bits image sensor. Channel width and length of the FET were 100μm and 10μm, respectively, and width, length and thickness of the photo-conductor were 670μm, 10μm and 0.13μm, respectively, and storage capacitor was 6.1pF.

Figure 4 shows image picked-up from the 8-bits device. Frequency, width and amplitude of the clock pulse were 300Hz, 3.3ms and 40V, respectively. It is worthy to note that the device can in principle pick-up grey-scale image.

Figure 5 shows the output (average) current flowing through a unit cell as a function of pulse width for various intensities of illumination. Under weak illumination, the output current saturated at wide pulse. This means that photo-current was accumulated in the capacitor during the pulse interval, i.e., the principal operational mechanism was verified.

Figure 6 shows the normalized output current flowing through a unit cell as a function of pulse width for various storage capacitances. As the capacitance decreased, saturating point moved to the left. This means that the increase of operating frequency is possible by decreasing the storage capacitance.

The features of the proposed device will be summarized as follows:

1) The accumulation of photo-current can be realized by small capacitance and the gain of photo-conductor can be utilized. This results in high sensitivity.

2) There is a possibility of cheap and large-area image sensor

In conclusion, a-Si image sensor was demonstrated. This device will be useful for the cheap and large-area image sensor, for example Facsimile.

The authors thank the Ministry of Education, Research and Culture, Japanese Government for the support of this work with a Grant in Aid.

References

1) H.Hayama and M. Matsumura; Appl. Phys. Lett.,36, 754(1980).

2) M.Matsumura and H. Hayama; submitted to Appl. Phys. Lett.

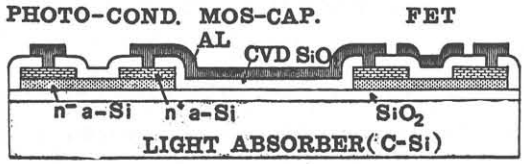

Fig.1. Cross sectional view of unit cell

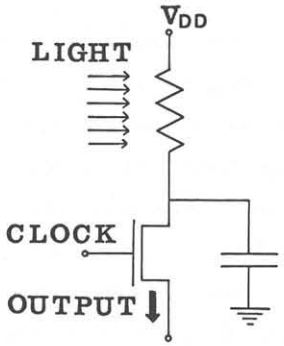

Fig.2 equivalent circuit of unit cell

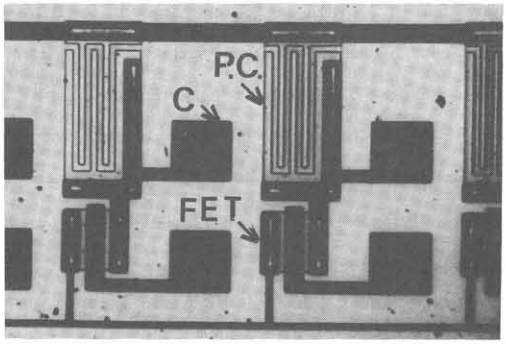

Fig.3 Photograph of 8-bits image sensor IC

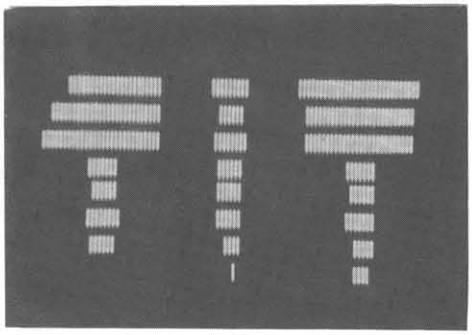

Fig.4 Image (TIT) picked-up by 8-bits image sensor IC

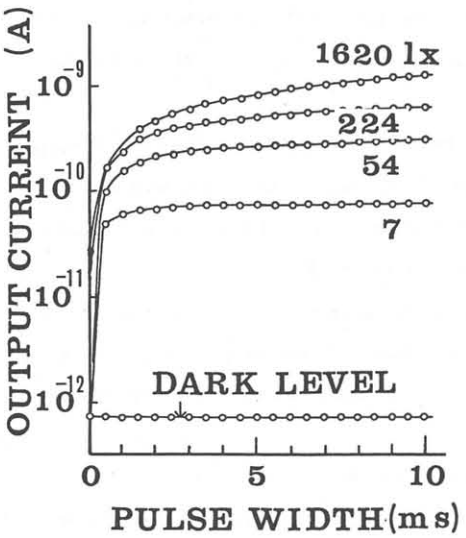

Fig.5 Effect of illumination

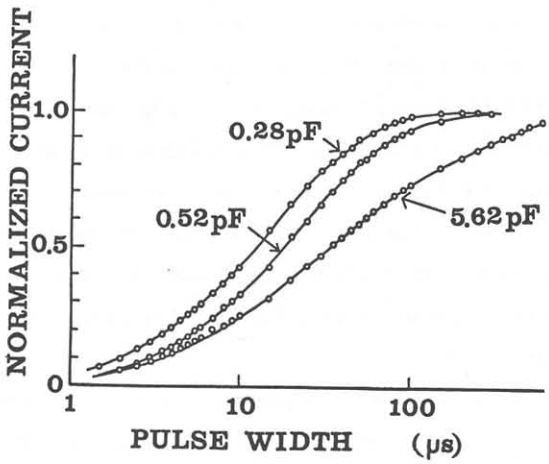

Fig.6 Effect of storage capacitance