Digest of Tech. Papers The 7th Conf. on Solid State Devices, Tokyo, Sep. 1975

B-4-2 **Application of Plasma Coupled Device to Solid State Image Sensors**

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A plasma coupled semiconductor device (PCD) is one of the integrated type functional devices consisting of the basic units of the three-terminal current controlled negative resistance elements.[1] Many functions such as shift register, various logic operations and imaging operations can be realized using the PCD.[2), 3)]

The PCD optical imaging devices follows two approaches. One is a self-scanning system, in which negative resistance elements in the PCD array are used as photosensors, and some results are already reported. In the other system,an array of photosensor is attached to the PCD scanning circuit. Comparing these two systems, the latter is more advantageous than the former because of lower power consumption, higher pakkage density, gray-scale reproduction capability and so forth.

The objective of this paper is to propose a new method of composing a self-scanned solid state imager using the PCD as a scanner, and the results of the experimental fabrication are also presented.

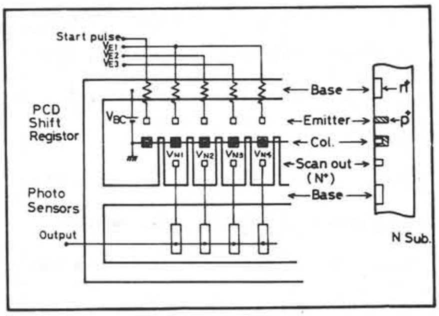


Fig.1 Diagram of the PCD image sensor

Figure 1 shows a diagram of this imager circuitry for a linear sensor array. In this device, the ohmic electrodes (n^+) are formed near the collectors of the each element. These are connected to the switching gates of each photosensor. When one element of the PCD is "on" , the potential V_n of the n^+ electrode which corresponds to this element drops owing to the conductivity modulation arround the collector region. This potential drop is applied to the switching gate of the photosensor, and photosignal is read out. When "on" state is changed to the "off" state by the clock pulses, the potential V_n of the n^+ electrode is recovered to the base potential. This potential change is transferred sequentially by the PCD shift-register. Thus the scanning operation of the photosensors array is realized by the PCD.

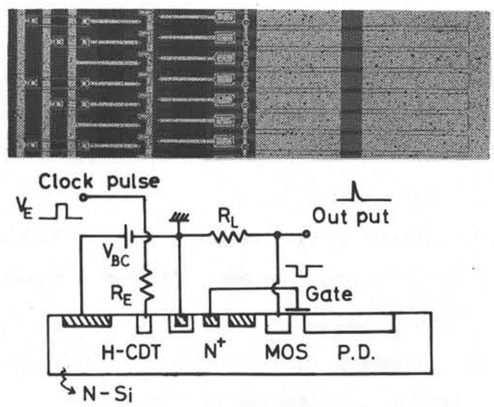


Fig.2 Photograph of a portion together with the cross-sectional view of the device(MOS-type)

MOS and bipolar type photosensor array are designed and fabricated successfully to be proved to show the excellent imaging performances. Photographs of a portion of the 64-bit (MOS-type) and 128-bit (bipolar-type) PCD image sensor together with the cross-view of each photosensor are shown in Fig. 2 and Fig. 3, respectively.

Figure 4 shows a typical waveform of the photosignal together with the dark noise, measured from the 128-bit image sensor. A S/N ratio of more than 35 dB, which is measured as the ratio of the saturated peak signal to the peak of the dark noise, is obtained without any noise eliminating circuit. This value is higher than the value obtained from the conventional MOS photosensor array which consists of photodiodes, switching MOSTs and a MOS shift-register.

Figure 5 shows a picture taken with the linear array of 128-bit image sensor.

The merits of the above-mentioned PCD imaging devices are as follows:

1) The structure is simple because one bit is composed of unit element of the PCD.

2) The PCD scanner operates over the frequency range of DC to several MHz.

3) The total power consumption is independent of the length of the array (i.e. bit-number).

4) The spike noise is small because of low clock pulse voltage.

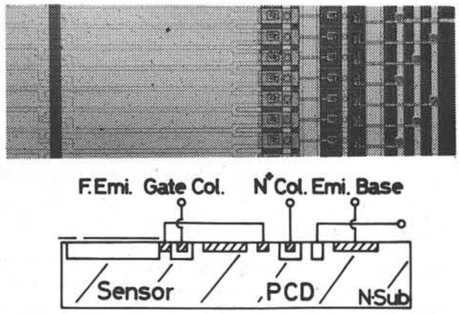
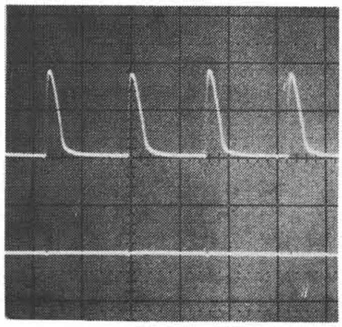


Fig.3 Photograph of a portion together with the cross-sectional view of the device(Bip.-type)



Ill.

Dark

V: 400μA/div. H: 2μsec/div.

Fig.4 Typical waveform of the photosignal together with the dark noise measured from the 128-bit imaging device

Fig.5 Picture taken with the 1[illegible] -bit imaging device

We would like to thank Dr.T.Suzuki for many helpful discussions in this work. Some of the devices used in the work were fabricated by Oki Electric Company.

References

1) T.Suzuki and Y.Mizushima: Proc.3rd CSSD Japan (1971), Japan Soc.Appl.Phys.Tokyo (1972) 40 ; Digest of Technical Papers ISSCC 28 (1972)

2) K.Kawarada, Y.Yamamoto et al : Proc.4th CSSD Japan (1972), Japan Soc.Appl.Phys.Tokyo (1973) 187

3) T.Suzuki, K.Kawarada et al : Proc.5th CSSD Japan (1973), Japan Soc.Appl.Phys.Tokyo (1974) 269