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C—3—4 Integrated Pyroelectric Infrared Sensor Using $PbTiO_3$ Thin Film

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Recently much attention has been paid to room-temperature-operated infrared sensor for a considerable amount of potential need from the application fields such as remote sensing, biomedical thermography and gas detection. Pyroelectric infrared sensor has some advantages as compared with photo-quantum effect type sensors like HgCdTe and Ge:Cu detectors operated at low temperature because the pyroelectric can be operated even at room temperature, has little wavelength dependence of the response over wide infrared range and has comparatively fast response. Especially $PbTiO_3$ shows excellent pyroelectric characteristics because of large pyroelectric coefficient and high Curie temperature. In recent years, we have succeeded in preparing $PbTiO_3$ thin film with rf sputtering method and moreover developed infrared-sensing FET(IR-OPFET)[1] and infrared sensor with low heat capacity[2] by depositing the $PbTiO_3$ thin film on Si wafer. In this paper, we have attempted to fabricate linear array sensor of the $PbTiO_3$ thin film for obtaining infrared image and studied essential characteristics about displaying method.

The $PbTiO_3$ thin film has been deposited on mica on which Pt electrodes are coated with rf sputtering and so sensor array with 16 sensitive elements has been fabricated by forming Al and infrared-absorbing Au-black. Infrared sensing performance of the $PbTiO_3$ film as a single sensor has been already reported,[1] and the responsivity and the detectivity are 465 V/W and 1.7×10^8 cm$\sqrt{Hz}$/W with bandwidth of 1 Hz at 15 Hz, respectively. The responsivity is almost equal to that of $PbTiO_3$ ceramic, but the detectivity is one order of magnitude smaller than that of the ceramic. Measurement system for imaging is shown in Fig. 1. Infrared light is coming through a chopper to a mirror and is focused on the linear sensor array. Figure 2 shows sampling circuit and pulse trains applied

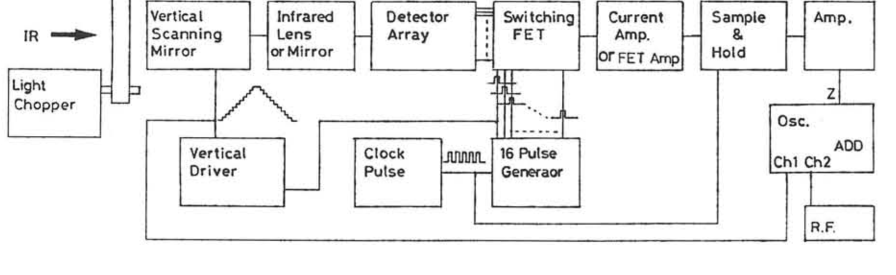

Fig. 1 Block diagram for infrared imaging.

to gates of switching FET's. Pyroelectric charges stored in an interval of T_s are converted to pulse train by applying the gate pulses with width T_p, and is read out with an amplifier. The output of the amplifier is held during an interval of T_s and modulates brightness of an oscilloscope. X-axis and Y-axis of the oscilloscope are controlled by a vertical driver and a rf generator.

Figure 3 shows output current vs. T_s characteristics in an element of the array as a parameter of chopping frequency f_{ch}. The output current is proportional to T_s as temperature of the film increases with a constant rate under a constant illumination and so the charge is proportional to T_s. When T_s is larger than $1/2f_{ch}$, the chopper interrupts the light on the sensor arrays and so the current decreases abruptly. At high chopper frequency, the current is larger because the absorbed infrared energy(heat) is not conducted so much to the entire region of the element in a short time, the effective heat capacity reduces and the temperature change increases. Figure 4 shows an example of imaging of an letter "K". In this case, frequencies of clock pulse and mirror motion are 8 KHz and 15.6 Hz, respectively. There are defect points in the image and this is not satisfactory, but could be improved by better signal processing and array preparation.

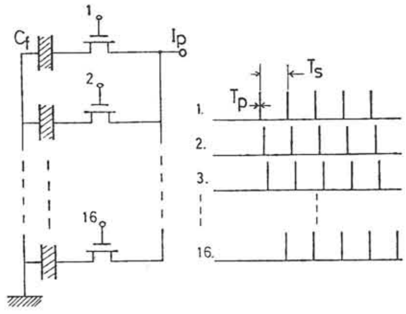

Fig. 2 Reading circuit of linear array and timing pulse of gate.

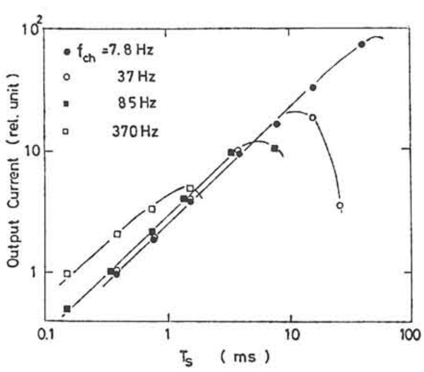

Fig. 3 T_s dependence of output current.

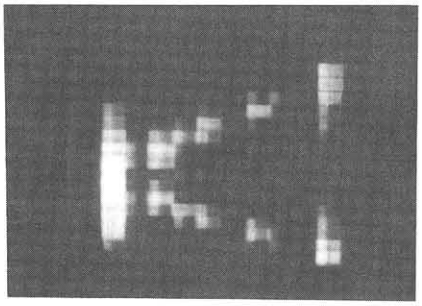

Fig. 4 An example of obtained infrared image.

Refences

1) M. OKUYAMA, Y.MATSUI, H. SETO and Y. HAMAKAWA: Jpn. J. Appl. Phys. Suppl. 20-1 (1981) 315.

2) M. OKUYAMA, H. SETO, M. KOJIMA, Y. MATSUI and Y. HAMAKAWA: Jpn. J. Appl. Phys. Suppl. 21-1 (1982) 225.