[Pulse Photoconductivity Method applied to Contactless Testing for LSI-Kojiro Shimizu]

[M.Furuta/M.Nagano/H.Kubota/K.Yoshinaga]
[k_shimizu@st.cs.kumamoto-u.ac.jp - m_nagano@st.cs.kumamoto-u.ac.jp]
[Graduate School of Science and Technology Kumamoto University.]
[2-39-1 Kurokami, Kumamoto, 860-8555 JAPAN]
Phone: +[81] -[96-342-3035] Fax: +[81]-[96-342-3065]

Abstract

A conventional test of evaluating electrical characteristics of semiconductor devices is called a wafer test. The wafer test uses a tester has measuring needles called a probe card. Using the probe card, by applying measuring needles to the pad of devices, the tester obtain electrical characteristics of devices.

However, this test method has problems such as damaging pads and wiring, measuring needles itself of wear, and variations of measured values due to contamination. Hence, it required for a new evaluation method which does not damage device and not deplete probe card. In this paper, we propose contactless testing for LSI applying PPCM (Pulse Photoconductivity Method)[1].

Pulse Photoconductivity Method

As shown in Fig. 1, a voltage is applied on a Si/SiO_2 specimen to the sample through the metal probe electrode close to the gate oxide on Si. At the time, internal electrical field E_{in} is generated and relaxed inside the oxide. After it is charged, the specimen is irradiated by a xenon-flash-lamp in order to excite electrons inside the oxide SiO_2. The light wavelength of this lamp is shorter than 300nm. Since the energy of this pulsed light is beyond 4eV, electrons are emitted and move from the valence band of Si to SiO_2, thus a photoconductivity signal can be obtained. The photoconductivity signal is proportion to E_{in} in the specimen.

Experimental method and results

We show the signal sequence diagram in Fig. 2, the experiment setup in Fig. 3. Photoconductive signal is amplified up to 100 times by a preamplifier before they are measured using a digital oscilloscope. To apply PPCM, a piece of Si wafer with 300nm SiO_2 (1cm×1cm) is used as the probe. We brought the probe to the Au pad in non-contact(～1um), and when we irradiated Xe pulse light and applied test patterns from the pad. We experimented about the following: (1) Signal sequence, (2) Proportional connection of applied voltages and photoconductivity signals, (3) Relation between test patterns and photoconductivity signals.

Experiment results are shown in Figs. 4, 5, and 6. As shown Fig. 4, the signal sequence is similar to the one we expected in Fig.3. As can be seen from Fig. 5, with increasing the applied voltage, photoconductivity signal increased. Figure 6 is the result when we applied a test pattern has two voltage level. Photoconductivity signal in case a high level voltage applied was bigger, according to the comparison between in case the high level voltage was applied and in case the low level voltage was applied.

Conclusion

In this paper, we propose contactless testing for LSI applying PPCM. Firstly, as expected, we show the experimental circuit moves with no problems. Secondly, we confirm that the photoconductivity signal is proportional to applied voltage of the pad. Thirdly, when we use the test pattern has two voltage levels, it is possible to get two photo conductivity signals which correspond to the voltage level. Considering the results, contactless testing for LSI by PPCM is useful.

In the future, it seems to need an experiment by the light source which moves by a high frequency (MHz band). It is also necessary to be considering creation process of tester structure.

Reference

[1] Y. Nishi, et al., The International Symposium on Semiconductor Manufacturing, PC-P-064, Tokyo, Japan, (2010)

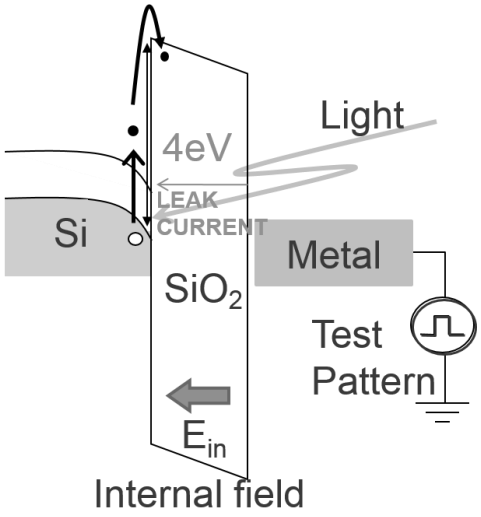

Fig. 1: PPCM model

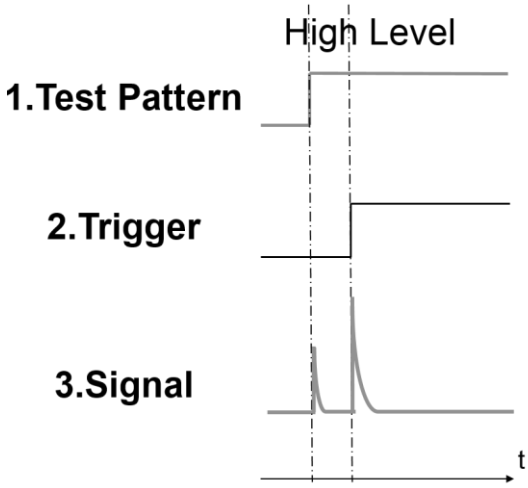

Fig. 2: Signal sequence (expect)

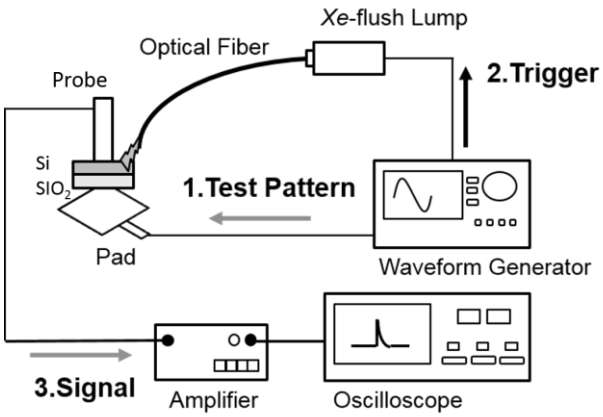

Fig. 3: Experiment setup

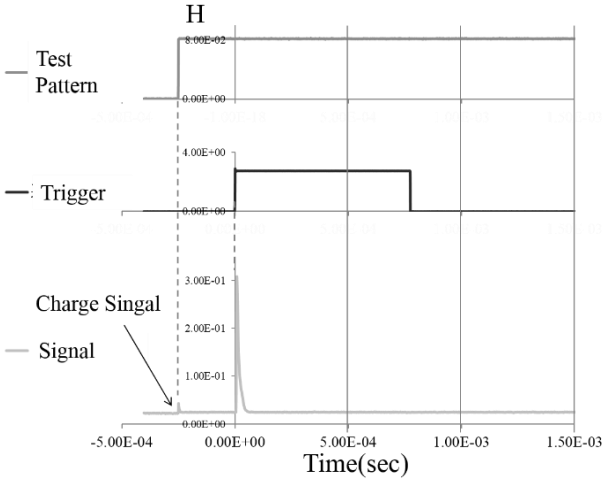

Fig. 4: Signal sequence (experiment)

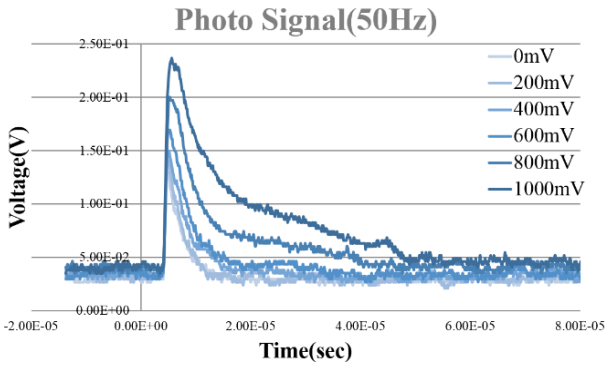

Fig. 5: PPCM signals

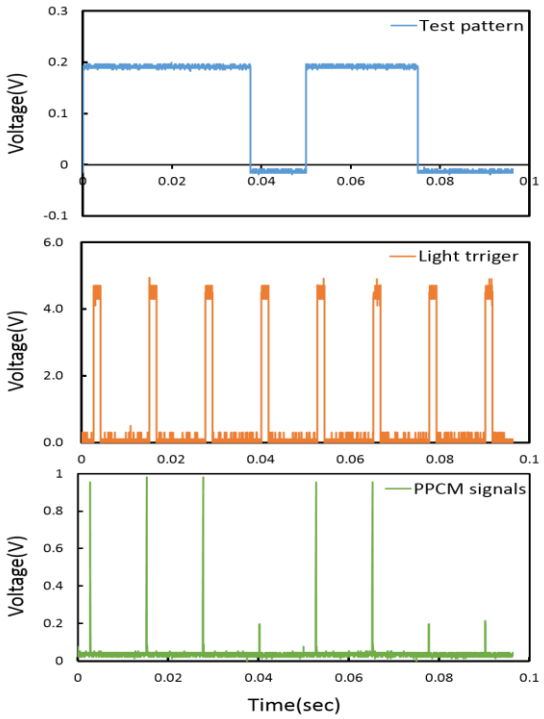

Fig. 6: PPCM signals by applying test pattern