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1. Introduction

A "real-time" basis analysis of a failure mechanism of power semiconductors under the power stress has significant advantages over a conventional "post defect" failure analysis (PD-FA) in capturing the real trigger point of the failure before the defects are propagated to substantially large areas. In this paper, the new technique for the real-time imaging of the device failure has been demonstrated using a high speed Scanning Acoustic Microscopy (SAT/SAM) [1-3]. Water as acoustic wave couplant in SAT system, which has been a major disadvantage of the system, is utilized as coolant for stressed power to the device.

2. Real Time Failure Imaging System Set-Up

The new "real-time" imaging technique was realized by combining a high speed SAT, an electrical power supply circuit for applying the power stress, and some other functions shown in Fig. 1. Commercially available SAT system (FineSAT FS100III, Hitachi E&S Co., Ltd.) and a TO-3P packaged n-channel MOSFET were used for defect imaging and DUT for this demonstration. The DUT was capsuled in a water-proof holder. The observational plane (back side copper) of the device was polished to a mirror finish to obtain better resolution of SAT images. This device was fixed on the bottom of the water tank in which a radiator (aluminium pipe connected to a chiller) is placed to utilize the water as coolant. A back side copper frame of the DUT, it is common to the drain terminal of MOSFET, was set to ground voltage with power circuit design to prevent the transducer from electric damage. The temperature of the heat sink of the DUT and surrounded water were monitored by fiber optic temperature probes.

Major barriers to accomplish this system are a severe noise due to a local convection with the heat and a formation of tiny bubbles on the observation surface. These problems are solves by introducing water jet along the scanning interface.

3. Case study of failure imaging of DUT

The movie image of a failure propagation of a DUT was successfully captured by the proposal protocol which SAT images continuously observed under a power cycle test are captured as a movie and high resolution images are also taken in each interval of the test. A series of pictures in Fig. 2 successfully depicted failure propagation in DUT just

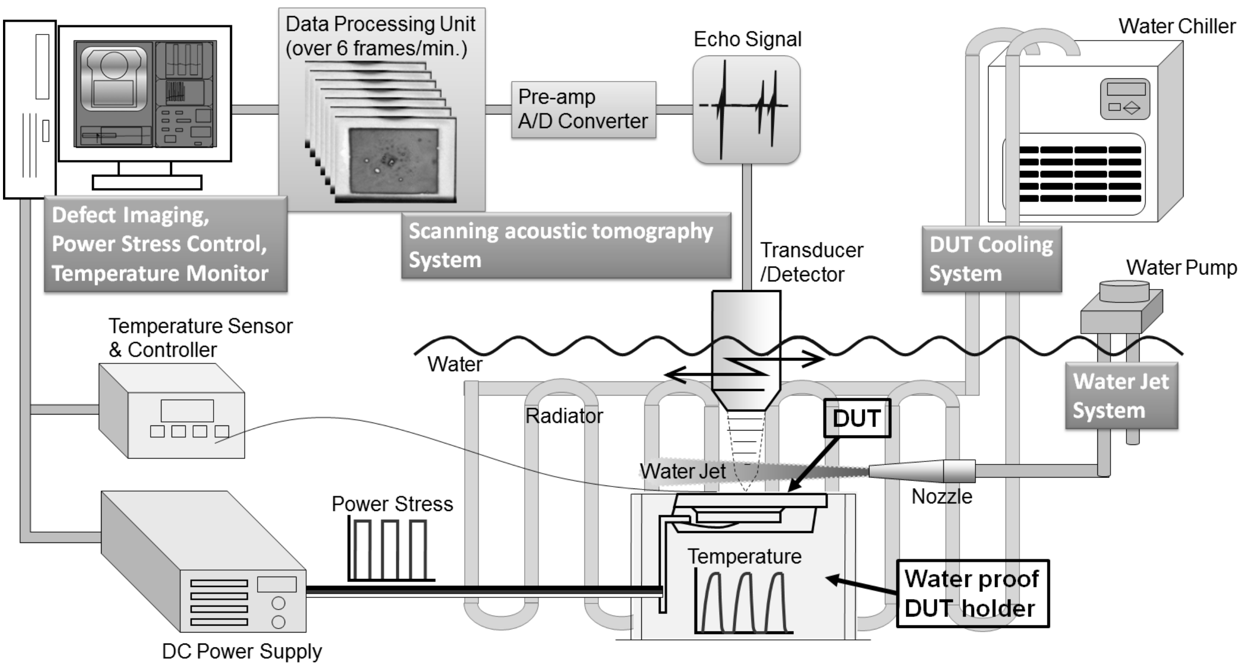

Fig. 1 Real Time Failure Imaging System under Power Stress Test.

before the device was broken.

4. Conclusion

A "real-time" imaging of the power device under power stress has been demonstrated. A high speed water flow system solved major problems of this method and resulted in a successful observation of defect propagation under a power stress test. It is noted that the couplant water for SAT is used as coolant for DUT and the heat generated by the power stress is diffused into the water, which enable the "real-time" basis inspection.

References

[1] G. De Liso, M. Muschitiello and M. Stucchi, SCANNING 15 (1993) 236-242.

[2] D. Martineau, T. Mazeaud, M. Legros, Ph. Dupuy and C. Levade, Microelectronics Reliability 50 (2010) 1768–1772.

[3] L. Angrisania, L. Bechoub, D. Dalletb, P. Dapontec and Y. Oustenb, Measurement 31 (2002) 77–91.

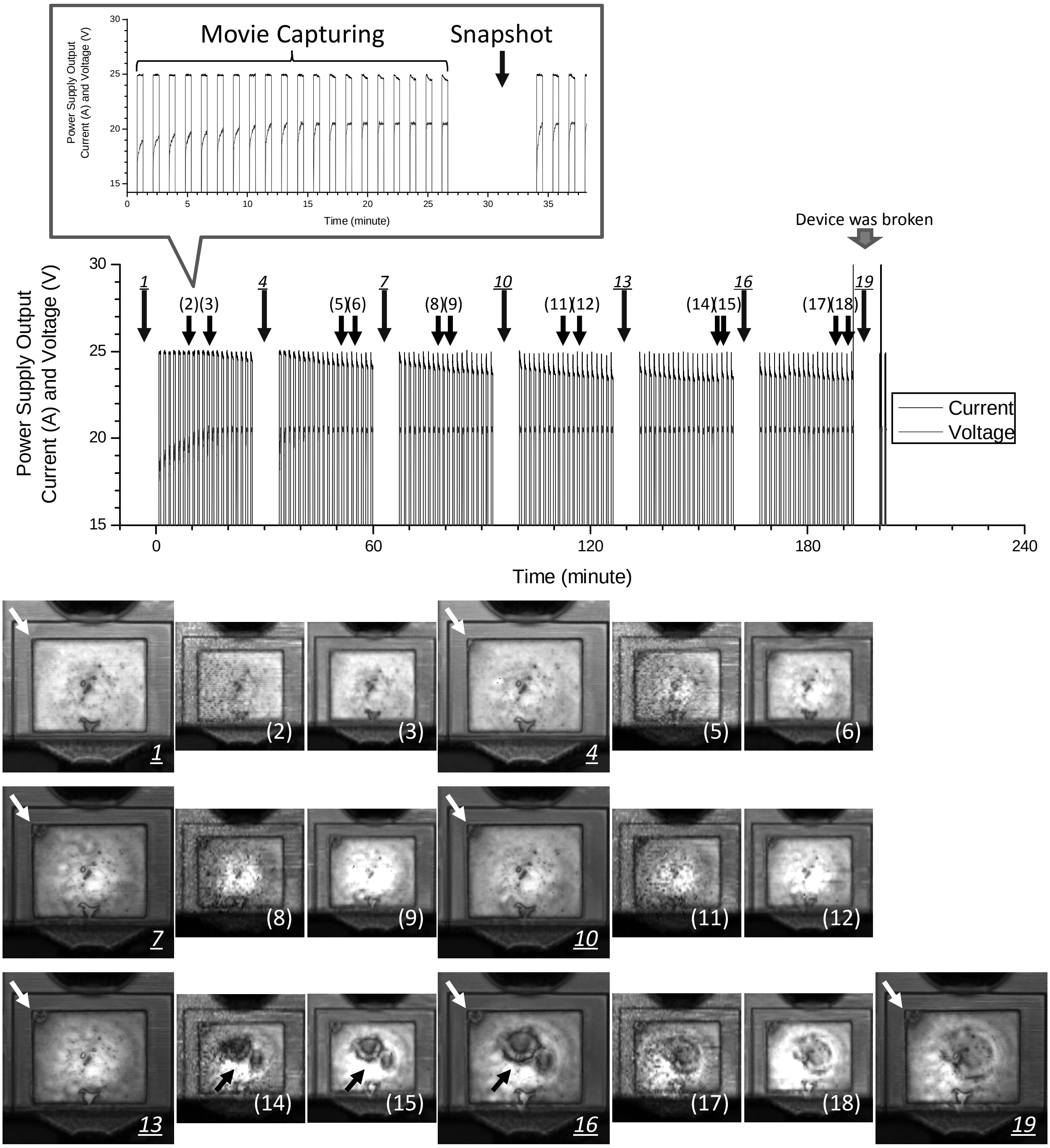

Fig. 2 Proposal protocol for real time failure imaging under power stress test and a result of its case study. A die detachment began from the upper left side (pointed by white arrow) and a remarkable image change successively occurred at the center of the die (in 13-16 frames). Finally the device was eventually destroyed (in 17-19 frames).