Failure prediction of power devices based on real-time monitoring

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Abstract

We have proposed a failure analysis based on real-time monitoring (RTM) of power devices under the acceleration test [1]. As the RTM records all phenomena in the process of failure of power devices, we can analyze the relation of physical phenomena occurs in the failure process and clarify the failure mechanism of power devices retroactively. In this paper, we discuss the failure prediction of power devices by using a huge date obtained by the RTM.

Fig.1 shows the functions of our RTM system we developed [1]. This system can monitor several kinds of parameters of the device under test (DUT). Applying this system to the power cycling test of the DUT, we can obtain a variation of temperature of the semiconductor chip, the package, electric properties, and internal structure. Indexing these parameters by qualitative and quantification, the failure process can be represented by the time series of these indexes (Fig.2). It is considered that different failure modes can be distinguished by the difference in the arrangement of indexes. For example, in the bond wire lift, a structure change at a bonding position or a change in electrical characteristics will be the main index. On the other hand, in the case of delamination of soldering, changes in the structure of the solder layer and changes in temperature characteristics will be the main indexes. Therefore, with this method, it is considered possible to predict the failure modes from the array of failure indexes. In addition, it is also considered possible to predict the lifetime of devices from the timing of index occurrence during the accelerated test and its quantitative progress. The lifetime is shorter as the index that causes the failure is generated in the early period and that quantitative progress is faster.

In order to realize this method, it is necessary a technique to select and indexing appropriate parameters related to the failure mode from the huge amount of RTM data. Technologies such as feature extraction and discrimination by machine learning will be useful for this purpose[2].

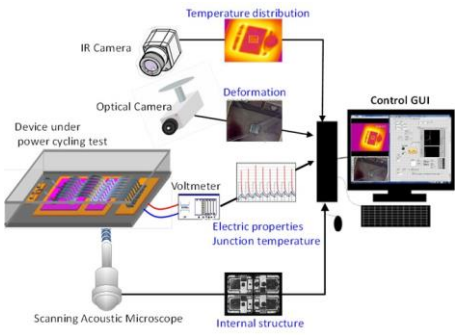

Fig.1 an exsample of RTM system

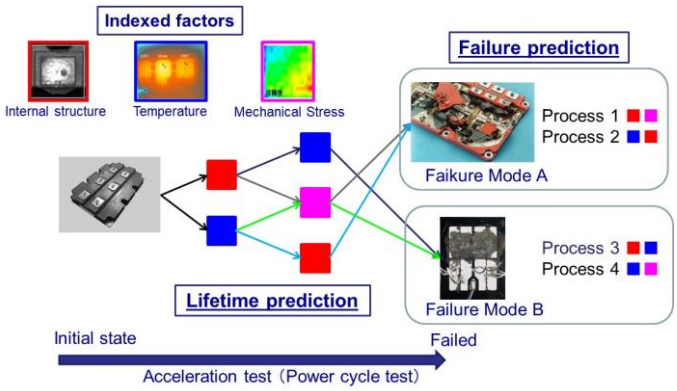

Fig.2 method for failure prediction based on RTM

References

[1] A. Watanabe, I. Omura, A power cycling degradation inspector of power semiconductor devices,Microelectronics Reliability 88–90 (2018) 458-461.

[2] Akihiko Watanabe, Naoto Hirose, Hyoungseop Kim and Ichiro Omura, Convolutional neural network (CNNs) based image diagnosis for failure analysis of power devices, Microelectronics Reliability 100-101 (2019) 113399.