Infrared thermography in semiconductor reliability testing

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Before being sold to customers, it is essential that the reliability of IC products is thoroughly tested. Only in this way can it be assured that they will remain functioning according to specifications over their full lifetime. To guarantee a lifetime of, for example, 10 years, some form of acceleration is necessary to keep test times within a reasonable limit. One of the most common ways to do this in the semiconductor industry is the so-called high-temperature operating life (HTOL) test. Here, the lifetime of the product at a certain application temperature is accelerated by mimicking the application in a test furnace at 150°C. Via the Arrhenius model and known activation energies for the failure modes, the application lifetime can thus be reduced to a matter of weeks.

It is essential to accurately measure the temperature of the IC devices in the test chamber for a valid HTOL procedure. As most ICs have some degree of self-heating due to internal power dissipation, the test chamber needs to be set at a lower temperature than 150°C to reach the correct product temperature—and this temperature needs to be measured *in situ*. If the test temperature is too high, the products will be overstressed and might unjustly fail and be rejected. In contrast, if the temperature is too low, the full lifetime will not be properly covered, and products might be sold that will fail before their guaranteed date.

In this paper, we will present our method to accurately measure the temperature of HTOL test samples using infrared thermography. We will discuss essential aspects such as compensating for an unknown emissivity, correcting for insufficient camera spatial resolution when the samples are too small and/or too far away, and the importance of camera calibration using black bodies. It is shown that, when all aspects are carefully addressed, accuracies of the order of ±1°C can be obtained.

Keywords

Accuracy, calibration, furnace, emissivity, HTOL, *in situ* measurement, integrated circuits, IC, life time testing, semiconductor, spatial resolution, test chamber