IXYS UK WESTCODE

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Issue: 1

An application note on wearout failure mechanisms

In general, the overall reliability of power semiconductor devices is represented by the “bathtub” curve shown in figure 1. The wearout phase of a device is linked to the general accumulation of physical damage under the operating load conditions in the application. The main changes in the properties of the device are linked to mechanical wear out due to the differences in the thermal expansion coefficients of the components in the housing. The surface of the die can show significant “scrubbing” due to expansion and contraction of the components. The scrubbing may lead to the formation of intermetallic compounds at these component interfaces as shown in figures 2-4. The build-up can then lead to changes in the on-state, V_T or forward voltage, V_F characteristic and in addition changes in the junction leakage current over long periods of time.

It is difficult to provide actual quantitative values to the X axis as this will depend very much on the conditions in the application. However, for many applications it is prudent to consider a refurbishment program after around thirty years’ service.

Generally, it is not good practice to remove a device from an assembly and then re-mount that device back into the same assembly using the same components. The device is unlikely to be re-located in exactly the same orientation in the clamp assembly, so the contact of the components is likely to be compromised due to the extended time in service.

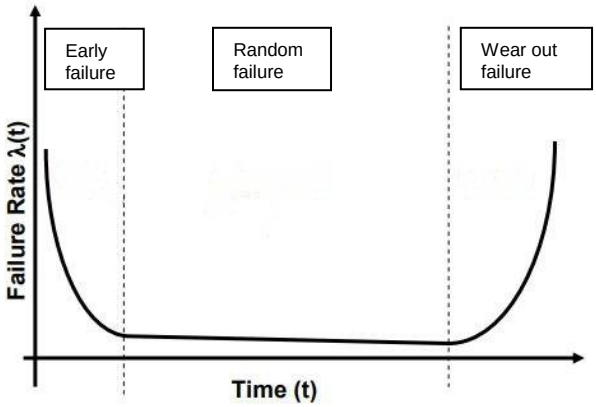


Figure 1: Typical “bathtub” curve



Figure 2: Initial evidence of thermal cycling scrubbing at the edge on the cathode contact area



Figure 3: Initial evidence of thermal cycling scrubbing on the anode molybdenum contact

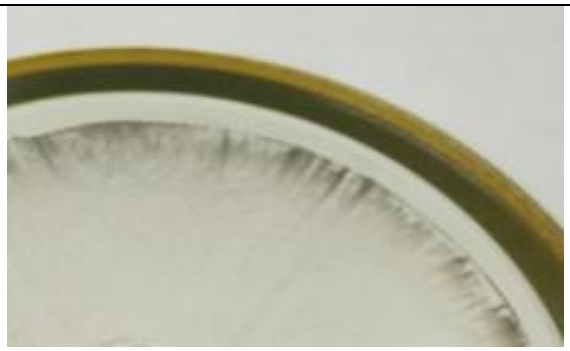


Figure 4: More extensive evidence of thermal cycling scrubbing at the edge on the cathode contact area

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