Not a Firecracker - Comparison of Failure Mode in Solid Tantalum Capacitors with MnO2 and Polymer Cathodes

Yuri Freeman & P. Lessner
KEMET Electronics Corporation
YuriFreeman@kemet.com

Solid Electrolytic Tantalum (Ta) capacitors with MnO2 cathode were invented at Bell Laboratories in late 1940s. In these capacitors, solid electrolyte MnO2 re-supplies oxygen in the oxide dielectric in a similar way to the liquid electrolyte in Wet Ta capacitors. The MnO2 also provides a strong self-healing property to the capacitor due to the phase transformations into lower manganese oxides with high resistivity, blocking current in defect spots of the dielectric. After the mass manufacturing of Ta-MnO2 capacitors was initiated in 1950s by Sprague Electric, USA, great numbers of these capacitors were used in most critical Military and Aerospace applications demonstrating exceptional stability and reliability.

Ta capacitors with polymer cathode (Ta-Poly) were introduced to the market in 1990s by NEC corporation, Japan. Since there was no active oxygen in the polymer to react with Ta metal upon the dielectric failure, the failure mode in Ta-Poly capacitors was assumed more benign than in Ta-MnO2 capacitors where at breakdown event oxygen released from the MnO2 cathode potentially may ignite and burn Ta anode. The idea was supported by the appearance of the surface-mount Ta capacitors subjected to the BDV test. The large dark areas, "burned spots", were often observed on the surface of the broken Ta-MnO2 parts while there were small/no dark areas on the surface of the broken Ta-Poly parts. References on the web can be found that teach that the "**composition and construction of a Ta-MnO2 capacitor is similar to that of a firecracker**" – not very encouraging news for the design engineers.

Results presented in the paper show that dark areas on the surface of the broken Ta-MnO2 capacitors have nothing to do with burning of Ta anode. Moreover, the parts made with advanced flawless technology (F-Tech) had more dark area after the BDV test than the parts made with the conventional technology. The presentation compares failure mode in Ta-MnO2 and Ta-Poly capacitors taking into consideration effects of the manufacturing technology and working voltage (thickness of the dielectric). The environmental stability of Ta-MnO2 and Ta-Poly capacitors is also discussed and recommendations on the safe, stable, and reliable types of Ta capacitors to use in different application conditions are included.