Update

News for KEMET Electronics Corp. Customers
August 2000

Tantalum Applications - Reply to General Question

Derating Polymer-Tantalum Capacitors

Tantalum History

The standard practice preached by almost all manufacturers of solid tantalum capacitors has included a recommendation that the devices be used in applications where the operational voltage would be no more than ½ of the rated. This 50% derating factor assures reasonable failure rates, especially for the power-on conditions experienced in most applications. The processing and materials involved with the T520, T530, or KO-CAP® capacitors involving a polymer cathode system are radically different from those of the traditional MnO_2.

SSST Testing

We have recently begun to rely on SSST (Surge Step Stress Test) results as an indicator of susceptibility to power-on failures as we have seen many instances where the projected failure rates and experienced rates have been the same. (See Update – May 2000 – "Surge Step Stress Testing of Tantalum Capacitors.") Figure 1 represents the mean data from sample batches run with MnO_2 and polymer. This report covers batches tested from September of 1999 through March of 2000. The sample size varied between 80 and 200 pieces each. The first row lists the percentage of rated voltage where the 100-PPM failure rate level would be projected. The last three rows show the projected failure rates (PPM) for voltage applications of 50%, 80% and 90% of rated voltages.

Means

	MnO_2 Production (27 batches)	KO-CAP Production (37 batches)
100 PPM @ (%Vr)	69%	92%
FR@ 50%Vr (PPM)	13	2
FR @ 80%Vr (PPM)	226	11
FR @ 90%Vr (PPM)	477	19

Figure 1. Mean PPM Failure Rates vs. Stress (%Vr)

The failure rate projection is 13 PPM for the MnO_2 product at 50% Vr, which is nearly equal to the polymer's projected failure rate of 11 PPM at 80% Vr. This correlation is again borne out when looking at the median values from the data collected, as in Figure 2. Here the projected failure rate of 9 PPM at 50% Vr for the MnO_2 correlates well with the 5-PPM failure rate for the polymer. We are not sure why the failure rates jump so dramatically to the next highest stress level for the MnO_2, as compared to the polymer at these chosen points, but again, this condition dramatically favors the polymer failure rates.

Median Values

	MnO_2 Production (27 batches)	KO-CAP Production (37 batches)
100 PPM @ (%Vr)	68%	114%
FR@ 50%Vr (PPM)	9	0
FR @ 80%Vr (PPM)	458	5
FR @ 90%Vr (PPM)	1700	19

Figure 2. Median PPM Failure Rates vs. Stress (%Vr)

Stress-Induced Failures

We believe that there may be several reasons for this variation, as the dielectrics and anode materials are exactly the same in these devices. One theory suggests that the MnO_2 material, as an inelastic or hard filler deposited in the channels within the device, may create faults in the dielectric as it is being processed. If a channel is seen as a necked-down constriction created with the tantalum particles as in Figure 3,

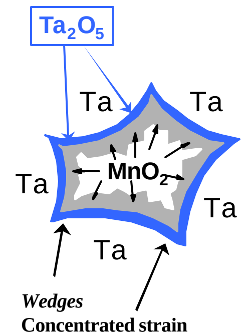
KEMET Electronics Corp. • P. O. Box 5928 • Greenville, SC 29606 • (864) 963-6300 • (864) 963-6521 FAX
WEB Page: www.kemet.com • e-mail: capmaster@kemet.com

then the MnO_2 is deposited along the inner walls of this channel. The process of depositing the MnO_2 involves a dip in manganous nitrate solution close to room ambient temperatures, and a conversion from the solution to a solid material at about +270°C. This dip and conversion process is repeated several times to assure complete coating of the dielectric layer and continuous connection into the inner depths of the channels. As these materials are different (Ta, Ta_2O_5, and MnO_2), their coefficients of thermal expansion will vary, and mismatches will generate mechanical forces.

Of critical importance is the "wedge" area where the glassy Ta_2O_5 fills a crevice created where two tantalum particles come together. This in turn creates a "wedge" of dielectric, which is filled by the cathode material. Any forces created with the MnO_2 in this area may be enough to crack or fracture the dielectric. Considering the temperatures involved in the processing, this theory is very plausible.

The T520 or KO-CAP capacitor has the same constricted channel structures, but the fill is created with a polymer – a soft, elastic material. Any mismatches in expansion will cause an elastic displacement of the polymer out of the wedge site. Additionally, the polymer deposition process involves a temperature range from +25°C to +65°C, hardly enough to generate forces even if it were as hard and brittle as the MnO_2.

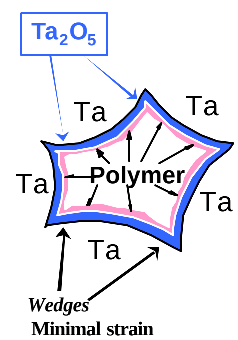
Induced Process Stress - MnO_2



In the tantalum anode pellet, areas of constriction exist where tantalum particles form a closed loop around an open channel. The MnO_2 filling this enclosure is a hard, crystalline material. The impregnation process involves dip at +25°C and conversion at +270°C. Stresses might be the root of cracks *created* in the dielectric.

Figure 3. Constricted channel with MnO_2 fill.

Reduced Process Stress - Polymer



The polymer material is soft and elastic. The forces generated because of mismatches in CTEs are insignificant when compared to MnO_2. The process involves conversion at room temperature after each dip cycle -- *not* at any elevated temperatures.

Figure 4. Constricted channel with polymer fill.

Recommended Derating Factors

We will keep the 50% derating factors as a recommended practice for the MnO_2 cathode system tantalums; but for the polymer-based cathode systems of the T520 and T530 series of the KO-CAP tantalum capacitors, we will recommend a 20% derating factor. This will allow the capacitors to be used at 80% of the rated voltage.

KEMET Technical Marketing
Tantalum Products

John Prymak
Technical Marketing Manager
Applications

John Moore
Director Technical Marketing

Nancy Reynolds
Technical Marketing Manager
Tantalum

KEMET Electronics Corp. • P. O. Box 5928 • Greenville, SC 29606 • (864) 963-6300 • (864) 963-6521 FAX
WEB Page: www.kemet.com • e-mail: capmaster@kemet.com