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Radiation Characterisation for New Tantalum Polymer Capacitors

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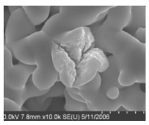
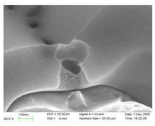
I. Abstract

Polymer tantalum capacitor technology was developed in response to demands from the market to lower the ESR of tantalum capacitors while preserving their small case size and high reliability. The technology is promising in several aspects. The higher quality interface between the dielectric and the polymer cathode increases the breakdown voltage of the device, as well as reducing its DC leakage current, even at extreme radiation exposure conditions.

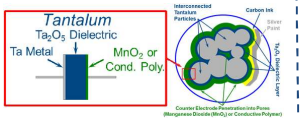
II. DUT Fabrication Technology

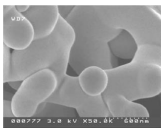


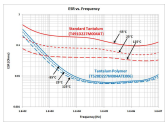


The traditional process of manufacturing the tantalum anode material resulted in cracks and pores.

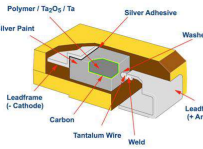
Traditional Technology (MnO_2 / Solid Tantalum)

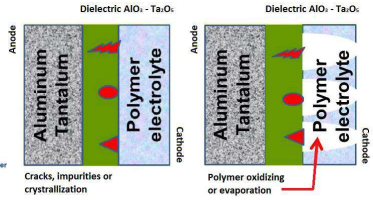






KEMET's new process created an ideally formed dielectric with practically no defects.





New Technology (Polymer Tantalum)

III. Experimental Set-Up & Testing Conditions

RADLAB Facility / Co-60 Source (ALTER TECHNOLOGY-SPAIN)

Accreditations awarded according to several radiation testing methods:

✓ ESCC 22900 (ECSS - Europe)
✓ TM1019 (DLA - USA)

These accreditations make this state-of-the-art radiation facility one of a kind in the word.

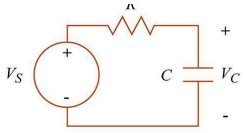
TABLE II.
Dose steps and dose rate for each capacitor style.

Style	Technology	Steps – Cumulative dose krad(Si) 1	2	3	4	Dose rate rad(Si)/h
T492	Solid MnO_2	25.267	46.039	98.779	211.749	224.9
T541	Polymer	25.267	46.039	98.779	211.749	224.9
T551	Polymer	25.379	46.244	99.218	212.691	225.9

TABLE III. ESR test conditions and limits for each capacitor style.

Style	Cap (µF)	ESR Test conditions	ESR Limits Min	Max	Unit
T492	10	f=100kHz, 1Vrms, Vbias=2.2Vdc	--	1.2	Ω
T541	337	f=100kHz, 1Vrms, Vbias=2.2Vdc	--	25	mΩ
T551	100	f=100kHz, 1Vrms, Vbias=2.2Vdc	--	100	mΩ

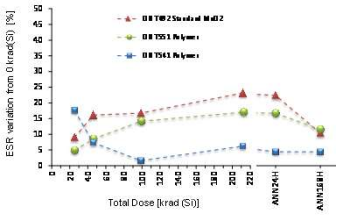
Note: In order to evaluate if the different types may have different behaviour, three different references were selected. This is the reason why the three candidates have also three different ESR limits.



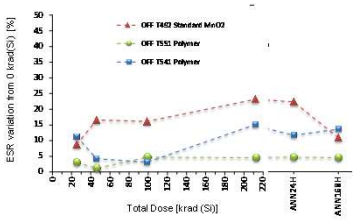
IV. Experimental Results

ESR shift over accumulated dose and annealing steps

biased (ON) samples



non - biased (OFF) samples



All ESR values are within limits after radiation exposure. 'Polymer capacitors' do not show any enhanced effect to accumulated dose compared to 'standard' capacitor

V. Conclusions & Further Actions

- 'Polymer capacitors' preserve their ability to operate properly under such environment as well as 'MnO_2 capacitors' and thus can be considered immune to radiation to the levels typically experienced in space.
- Due to ESR depends on temperature and polymer reliability, it would be desirable to complement this work, with an evaluation of the polymer behaviour after long low temperature periods.
- This would help to assess how the polymer properties may be affected by extreme temperatures in combination with TID exposure