WHY AND HOW TO USE TANTALUM CAPACITORS IN SATELLITES' SECONDARY DC BUS?

SPCD, October 2016

Content

General presentation about Exxelia and its tantalum entity (ex-FIRADEC)

Advantage of tantalum for this particular application

Why was tantalum out of popularity for this application?

Why it will change

EXXELIA GROUP

Designer and manufacturer of electrical and electromechanical innovative, high-tech and high-reliability solutions.

Paris
Headquarters

40 QPL
product series

12
Manufacturing locations worldwide

1600
Employees

4 SBUs
Strategic Business Units

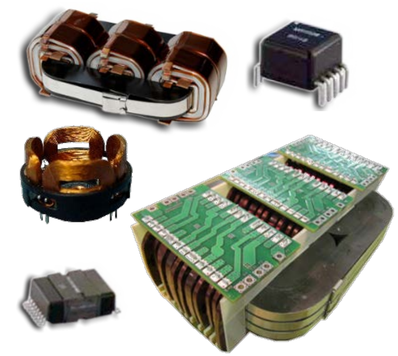
Exxelia Today

Eurofarad	Exxelia Technologies
Microspire	Exxelia Magnetics
N'Ergy	
Firadec	**Exxelia Tantalum**
Sic-Safco	Exxelia Sic-Safco
Temex Ceramics	Exxelia Temex
Astema	Exxelia Morocco
Dearborn	Exxelia Dearborn
Raf Tabtronic	Exxelia Raf Tabtronic
DeYoung	Exxelia DeYoung

EXXELIA GROUP

4 SBUs - 10 Product Lines

STRATEGIC BUSINESS UNITS	Solid Capacitors	Film & Electrolytic Capacitors	Magnetics	Electromechanical Solutions
	27 %	29 %	22 %	22 %

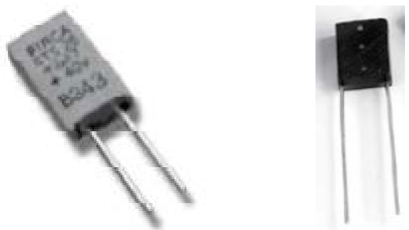


	Solid Capacitors	Film & Electrolytic Capacitors	Magnetics	Electromechanical Solutions
PRODUCT LINES	Ceramic Tantalum Materials & FTC	Film & Mica Aluminum Electrolytic	Wound Magnetic Components	Position Sensors, Slips Rings & Rotary Joints Sub-Assembly Filters Precision Mechanics
BRANDS	Exxelia Tantalum Exxelia Technologies Exxelia Temex	Exxelia Dearborn Exxelia Sic-Safco Exxelia Technologies	Exxelia Microspire Exxelia N'Ergy Exxelia RAF Tabtronics Exxelia Vietnam	Exxelia Technologies Exxelia Maroc

Exxelia Tantalum Product Portfolio

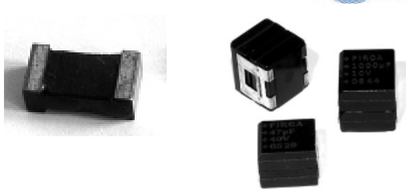
Solid Tantalum Capacitors

Axial



Moulded Case

esa



SMD Case

Wet Tantalum Capacitors

esa

Axial Wet Ta

Silver Case Ta

SMD Wet Ta

Why and how to use tantalum capacitors in Satellites secondary DC Bus?

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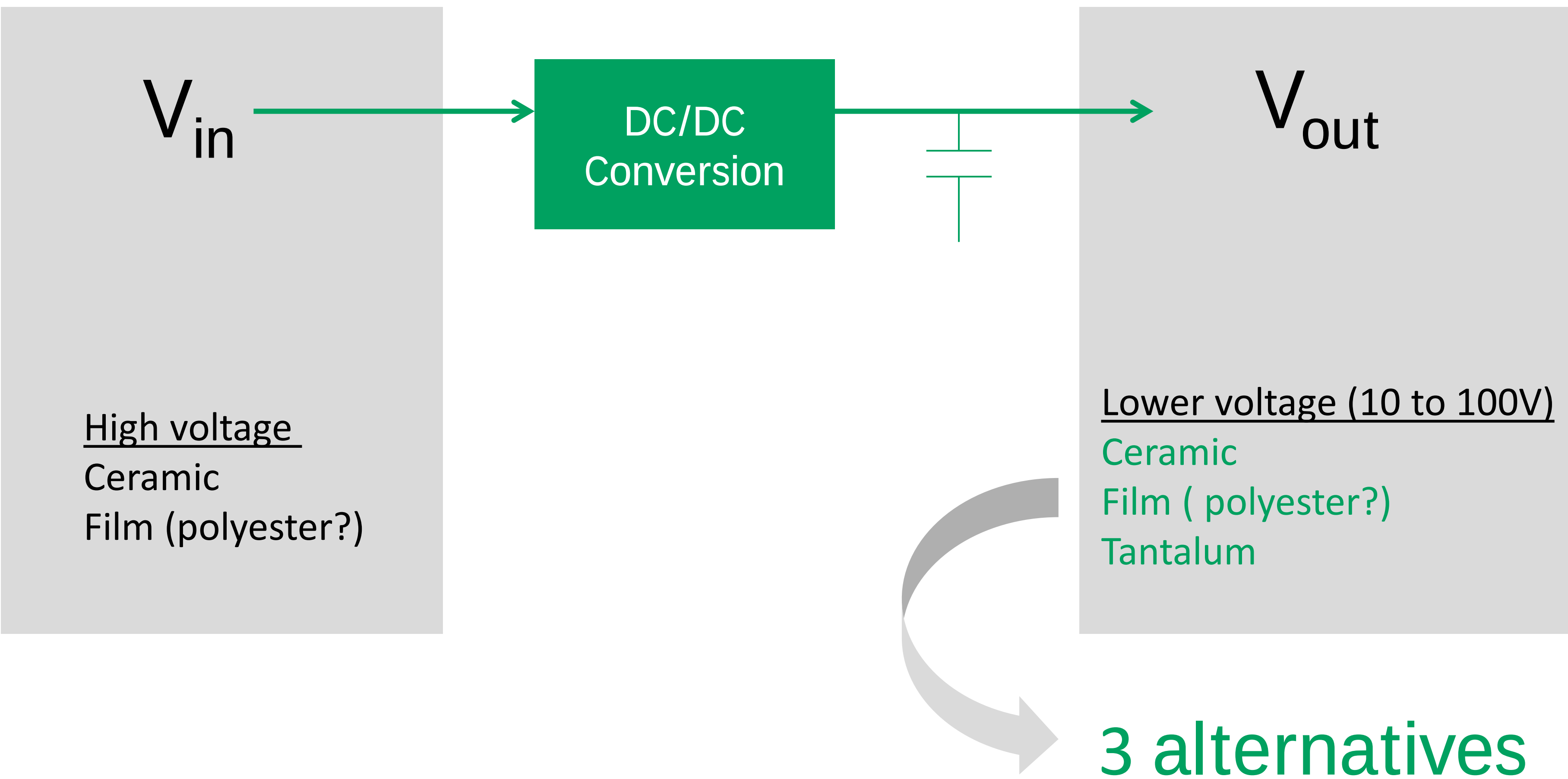
Main general DC/DC converter on a Satellite



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PROs & CONs of each technology

Caracteristics/ Technology	Ceramic	Film	Solid Tantalum	Wet tantalum
ESR	+	++	-	--
Capacitance/ volume	-	-	+	++
Ripple current	+	++	-	-
Weight of the function		++	--	
Price of the function	-	-	+	++

Main Advantage of Tantalum

(all values @50V)	Ceramic	Film	Solid tantalum	Wet tantalum
Max capacitance	3.3µF	27µF	47µF	750µF
Volume to achieve 10mF (mm^3)	881 664	1 980 000	160 325	35 412
Capacitance /volume ($\mu F/cm^3$)	11.3	5.03	62.14	281.3

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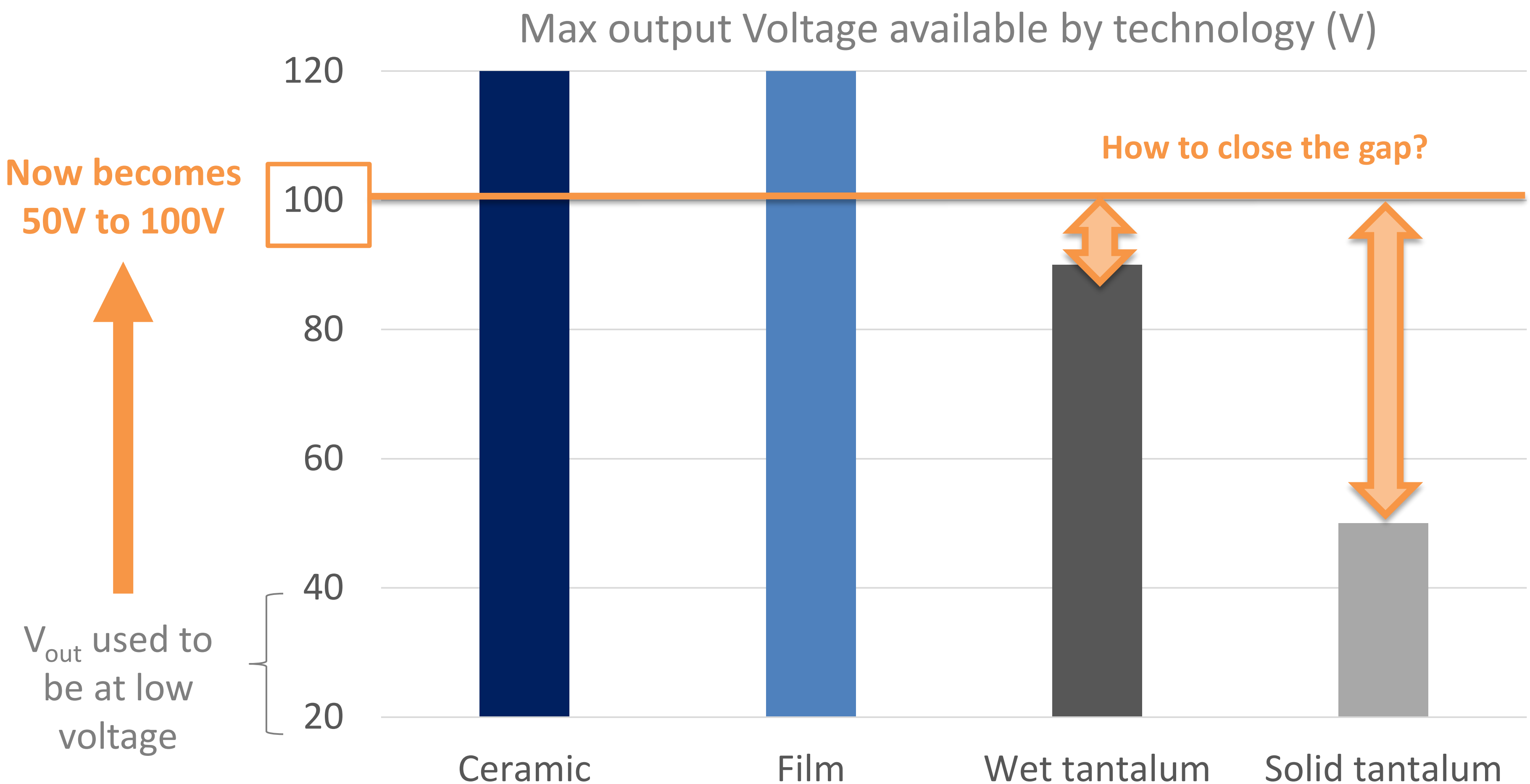
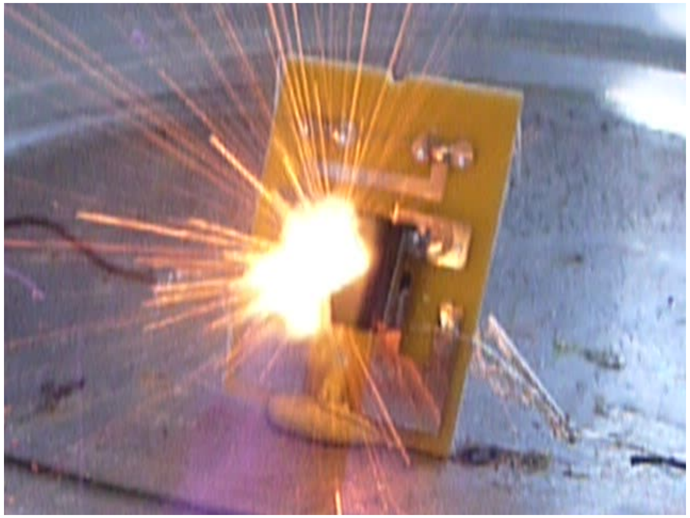
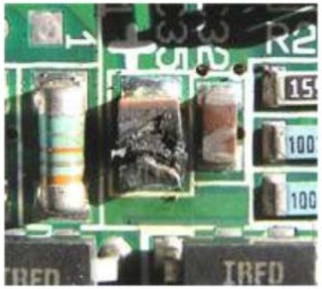
Why was tantalum unpopular these past years?



Why was tantalum unpopular these past years?





Failure mode of MnO2 solid tantalum could lead to open mode with thermal ignition of the capacitor

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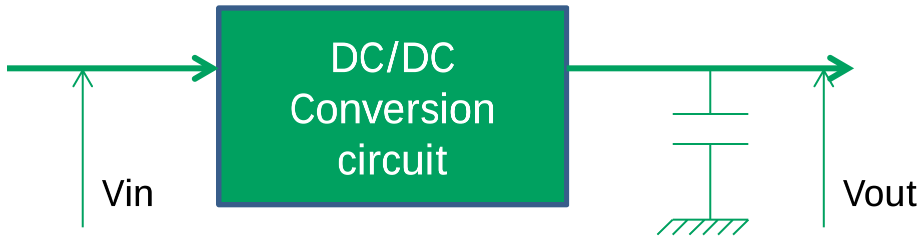
WT 82: High voltage wet tantalum

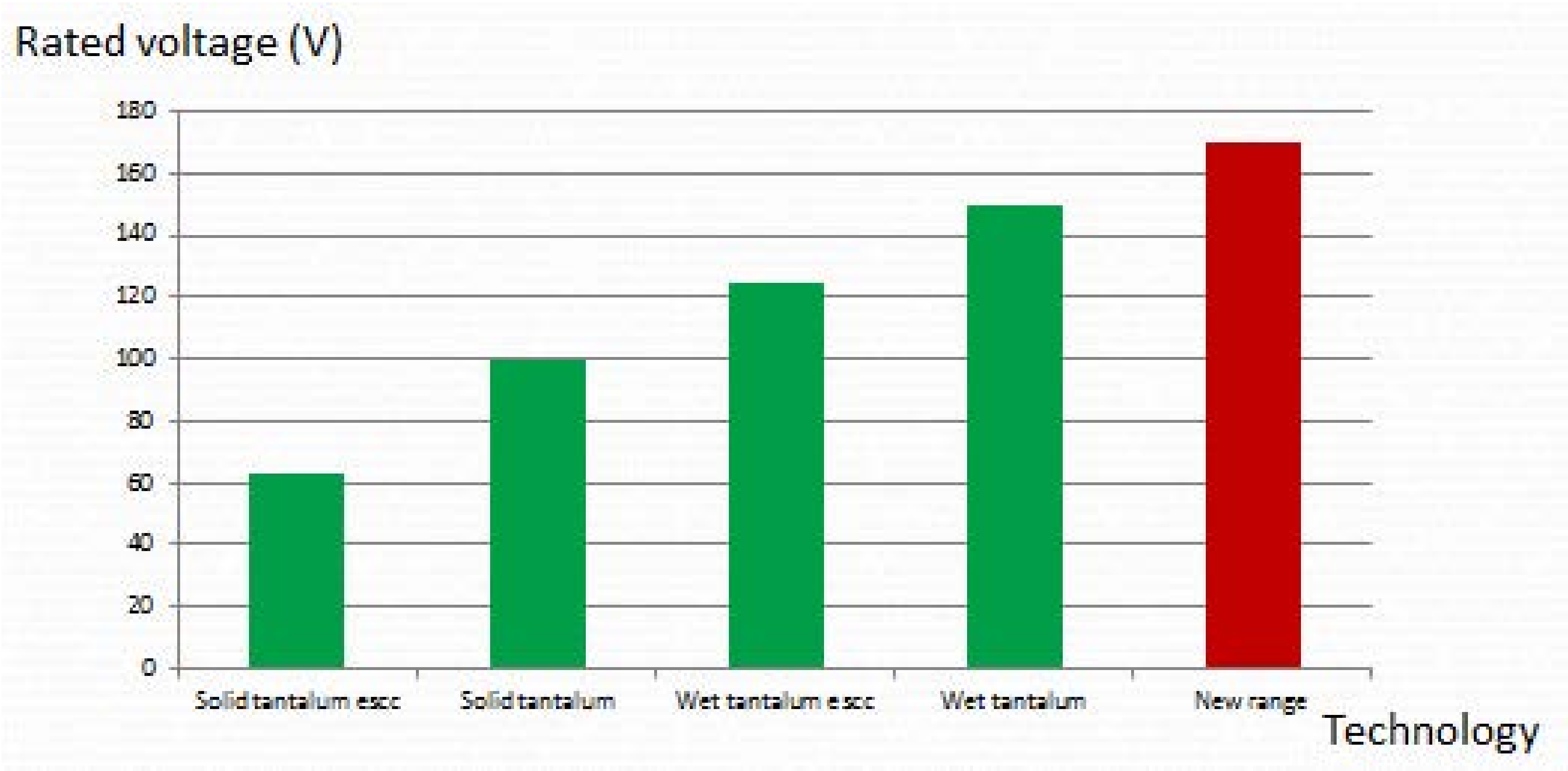
Tendancy in the market



Vout increased over the time.
More and more commonly Vout≥50V and now
Oftenly Vout=100V

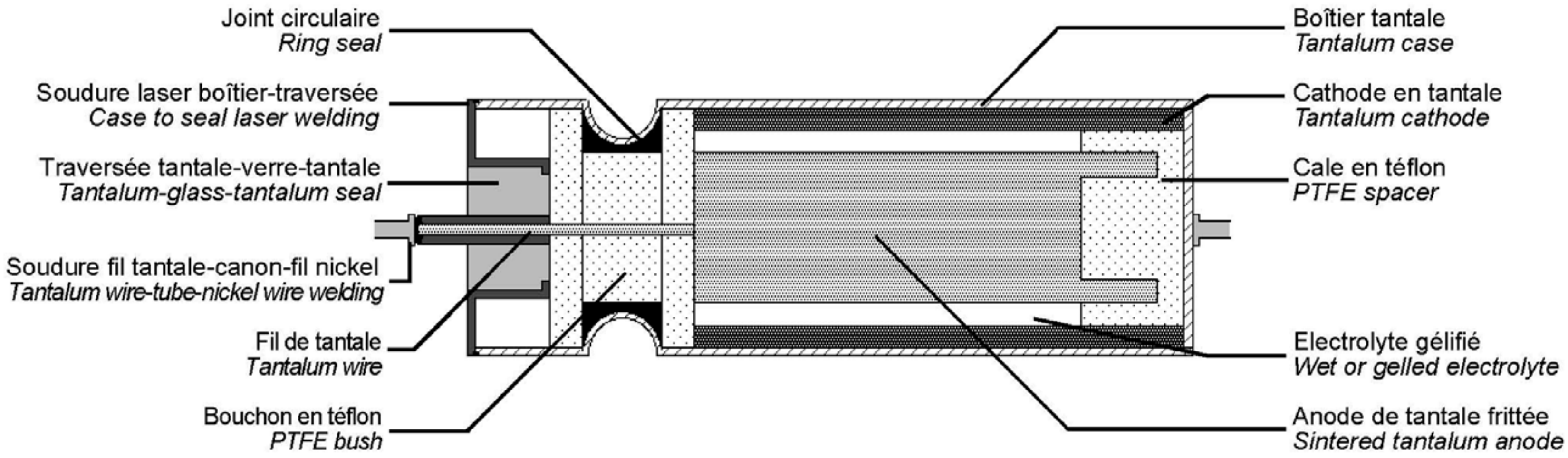
Need for capacitor at minimum 170V due to the derating in space application.

WT 82: High voltage wet tantalum



Solid tantalum escc:	Up to 63V	
Solid tantalum out of escc:	Up to 100V	
Wet tantalum escc:	Up to 125V	
Wet tantalum out of escc:	Up to 150V	New range (WT82): Up to 170V

WT 82: High voltage wet tantalum



First values made: 47µF 160V in D case
47µF 170V in D case
82µF 160V in D case
82µF 170V in D case

With high reliability levels in order to be used in space programs in the future.

WT82: Tests results at 170V

Operating life test at 70°C under rated voltage during 1000 hours

82µF 20% 170V D case

	Before life test			After life test			
	Cap.(µF)	TgD.(%)	Lc.(µA)	Cap.(µF)	dC/C(%)	TgD.(%)	Lc.(µA)
Limits	65.6/98.4	40	5		10	60	10
Min.	87,93	7,64	1,02	81,73	-7,66	6,96	0,56
Max.	89,09	9,23	1,23	82,85	-6,84	8,14	0,62
Moy.	88,62	8,52	1,10	82,22	-7,21	7,40	0,58
Std	0,387	0,46	0,061	0,341	0,27	0,41	0,017

Electricals parameters of capacitors are stable after 1000h under U_R at 70°C. The decreasing of capacitance is about 8% of initial value. No defect was appeared during the test.

➔ PASS

WT82: Failure rate calculation

FR = 3 x πT x πV x πC x πE x πq x 10^{-9}/ hour

Influence of the temperature:
πT = exp(1,8x$(T/70)^2$)
Let's consider the worst case: T=70.
πT = exp (1,8) = 6,05

Influence of the voltage:
πV = exp (($(Up/Ur)^2$)
In space, if derating = 0,6, we have:
πV = exp ($0,6^2$)= 1,43

Influence of the capacitance:
πC = 1,2 at 82µF

Influence of the qualification:
πQ = 2

Influence of surrounding conditions:
Satellite in orbit: πE = 0,5
Satellite launching: πE= 20

WT82: Failure rate calculation

Best case: satellite in orbit

$$FR = 31.10^{-9}$$

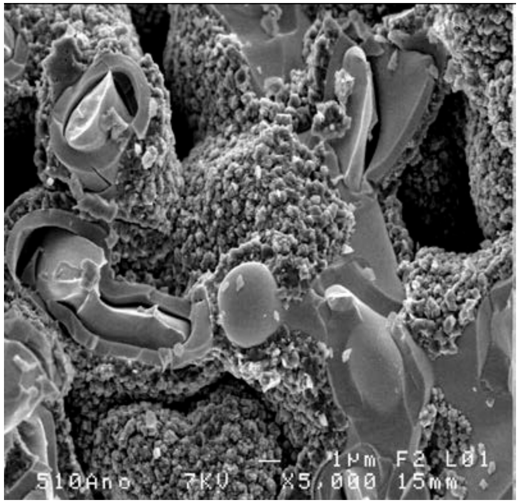
MTBF = 32 M hours

Worst case: Launcher

$$FR = 12{,}4.10^{-7}$$

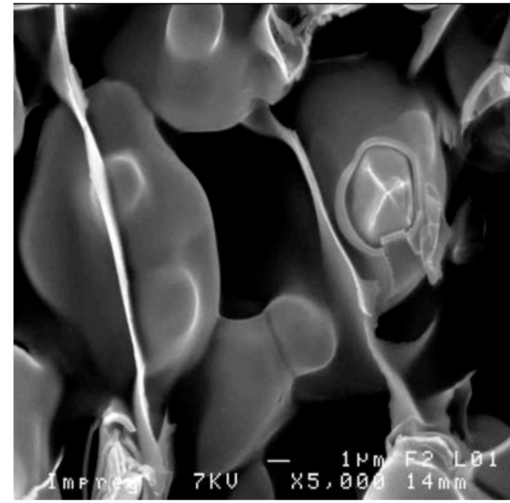
MTBF = 806 k hours

CTP21



Mn02

Internal structure
→



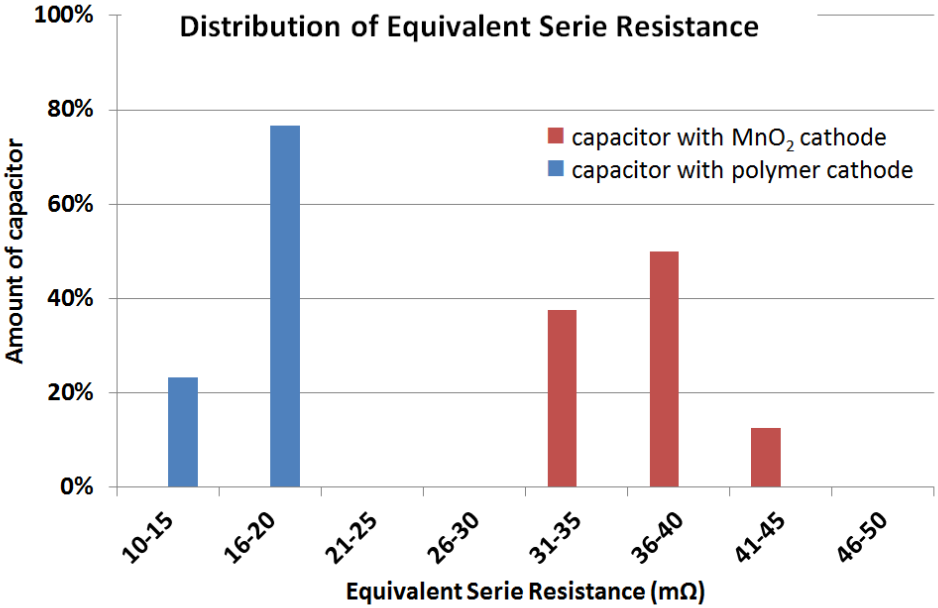
Polymer

Thermal ignition:

Does not happen with polymer

CTP21

Lowest ESR on the market



⇒ Twice less ESR compared to the same component in MnO_2 technology

High energy density

Typical capacitances

- 16V ⟶ 560µF
- 40V ⟶ 150µF
- 100V ⟶ 22µF

⇒ Allows electronic designs to be smaller

They're stackable!

CTP42

⇒ Twice as much capacitance
⇒ Half the ESR
⇒ Same implantation on the PCB

To Conclude...

Our goal is to provide you solutions for space designs of the future

Thank you for your attention