Space Passive Component Days

Introduction of Small Size MLCC to Aero-Space Application and its technology

FUKUI MURATA MFG.CO.,LTD.

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2013.09.25

CONTENTS

CONTENTS

Profile

Date of Establishment	**October 1944**
Date of Incorporation	**December 23, 1950**
Sales Amount	**584,662 million Yen**
Number of Subsidiaries	**77** **24 in Japan** **53 overseas**
Number of Employees	**37,420** **22,612 in Japan** **14,808 overseas**

※Sales amount, Operating Income…as of March 31, 2012

※Number of subsidiaries, Employees…as of January 31, 2013

Product Category

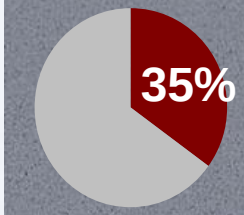
Module
Electronic Circuits

EI
Electronic Infrastructure

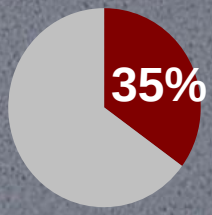
ASC
Application Specific Components

Global Market Share

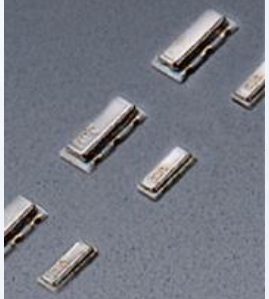
Chip Monolithic Ceramic Capacitors

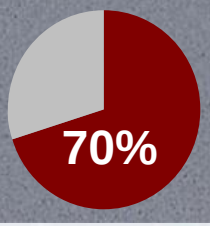


EMI Suppression Filters (EMIFIL®)

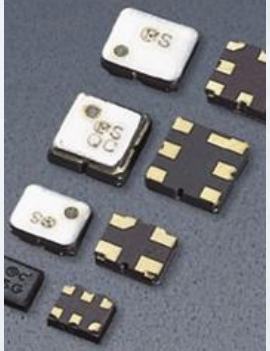


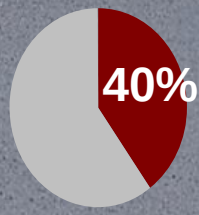
Ceramic Filters /Resonators



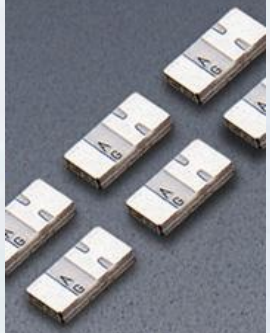


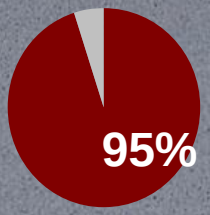
Surface Acoustic Wave Filters



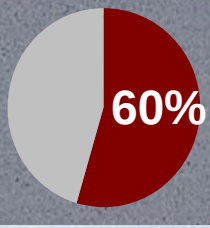


Shock Sensors





Connectivity Module



※Our presumption

CONTENTS

Background

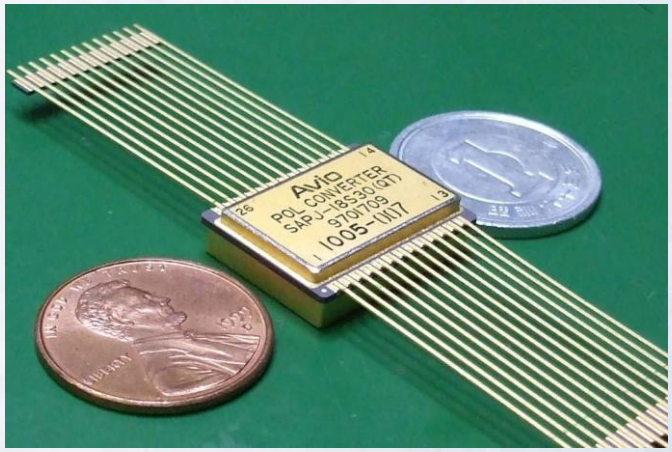
1. MURATA had required small size and high capacitance MLCC for POL DCDC converter from JAXA and Nippon Avionics Co., Ltd.

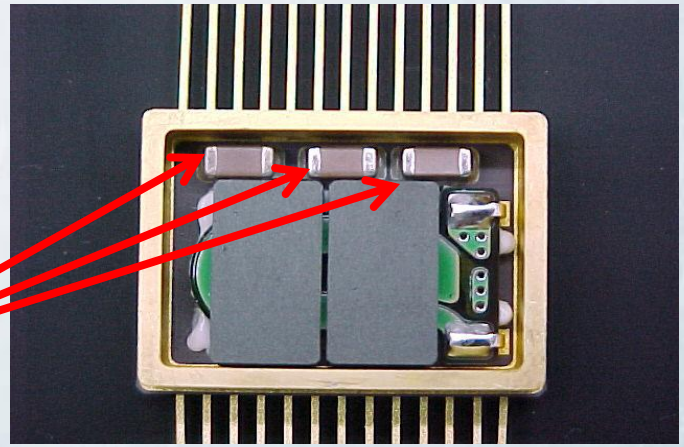
2. MURATA consider using automotive grade MLCC for space applications.

3. We determined voltage acceleration factor and experimental conditions, because of using thinner dielectric technology.

4. JUNE 2012, 5items qualified for space application parts from JAXA.

POL DCDC convertor





High capacitance MLCC

(Photo.: Nippon Avionics Co., Ltd.)

Small size and high capacitance MLCC products for space application

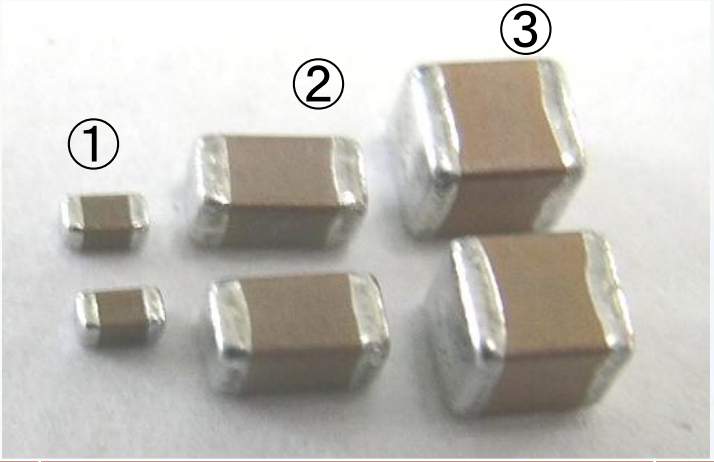
CAPACITORS, MINIATURE, HIGH-CAPACITY,
SURFACE MOUNT, FINE CERAMIC DIELECTRIC (J2040/M105),
HIGH RELIABILITY, SPACE USE,
DETAIL SPECIFICATION FOR

QTS：JAXA-QTS-2040/M105

CHARACTERISTIC

- ◆ Used thinner dielectric technology
  Design Thin　dielectric thin : 20um ⇒ 3～9um
- ◆Development for POL DC/DC convertor
- ◆Failure rate level　S level
- ◆CHARACTERISTIC　X7R
- ◆Capacitance tolerance　K (±10%)、M (±20%)
- ◆Terminal surface　：Y (Ni/Sn plate)、S (solder coat over Y)

Small size and high capacitance MLCC products for space application



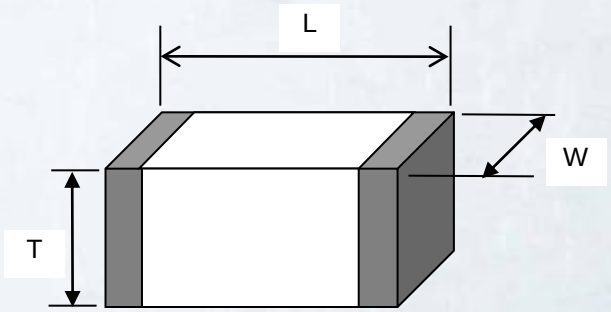


Photo.	Part No.	Ratio voltage (V)	Capacitance (uF)	Nominal Dimension L×W×T (mm)	Dielectric thickness (um)	Mass (mg) (Typical)
①	J2040/M105-1608X7RC104	25	0.1	1.6×0.8×0.8 0603 inch	9	7
①	J2040/M105-1608X7RB105	8	1.0	1.6×0.8×0.8 0603 inch	3	7
②	J2040/M105-3216X7RB106	8	10	3.2×1.6×1.6 1206 inch	3	55
②	J2040/M105-3216X7RA226	3.5	22	3.2×1.6×1.6 1206 inch	3	55
③	J2040/M105-3225X7RB226	8	22	3.2×2.5×2.5 1210 inch	3	130

From automotive to space grade

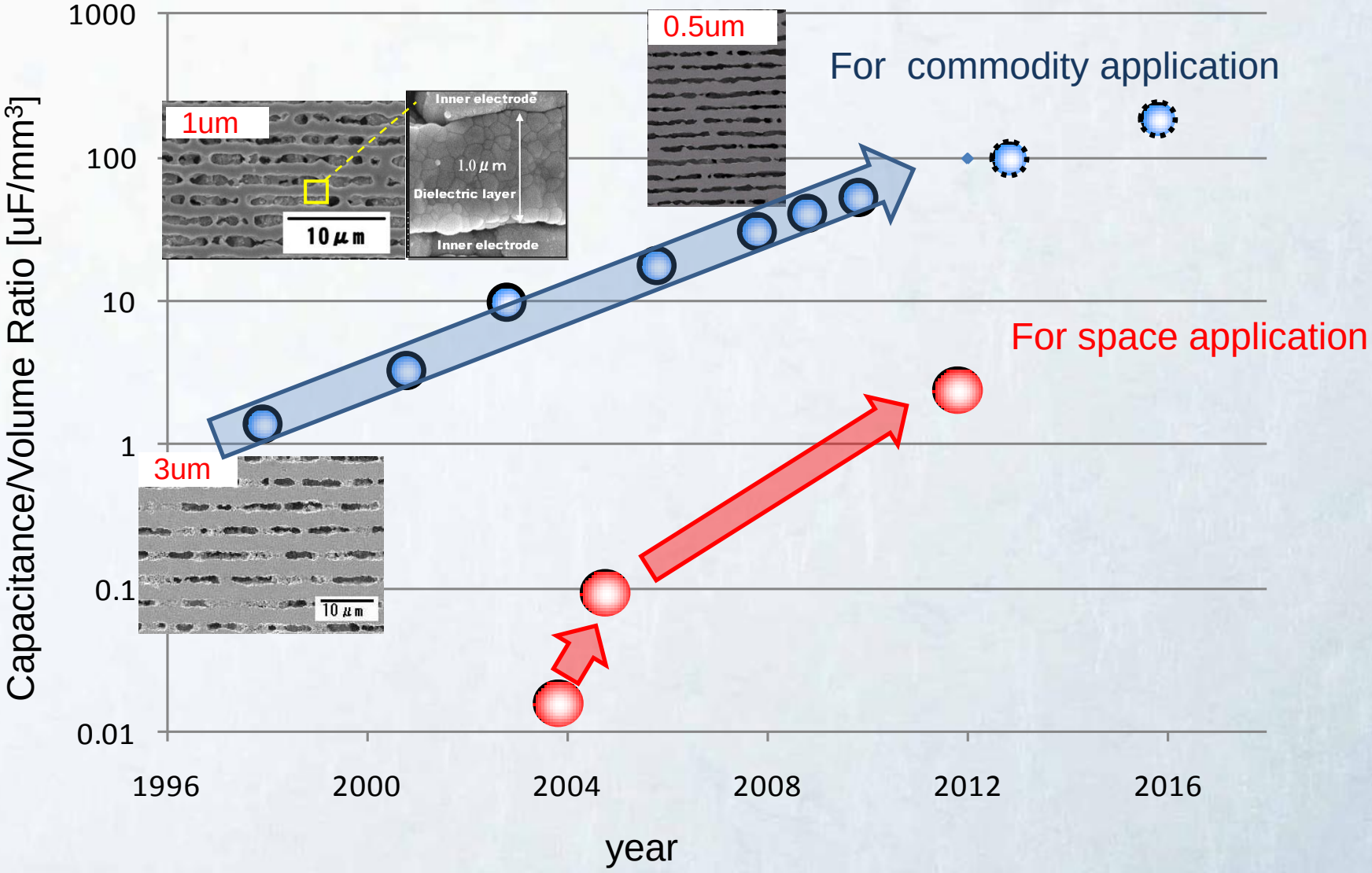
Automotive
GCM188R11H104KA42D
GCM188R71C105KA49D
GCM31CR71C106KA49L
GCM31CR70J226KE30B
GCM32ER71C226KE15L

Up-screening
Solder coating
Ratio voltage 1/2

Space
J2040/M105-1608X7RC104
J2040/M105-1608X7RB105
J2040/M105-3216X7RB106
J2040/M105-3216X7RA226
J2040/M105-3225X7RB226

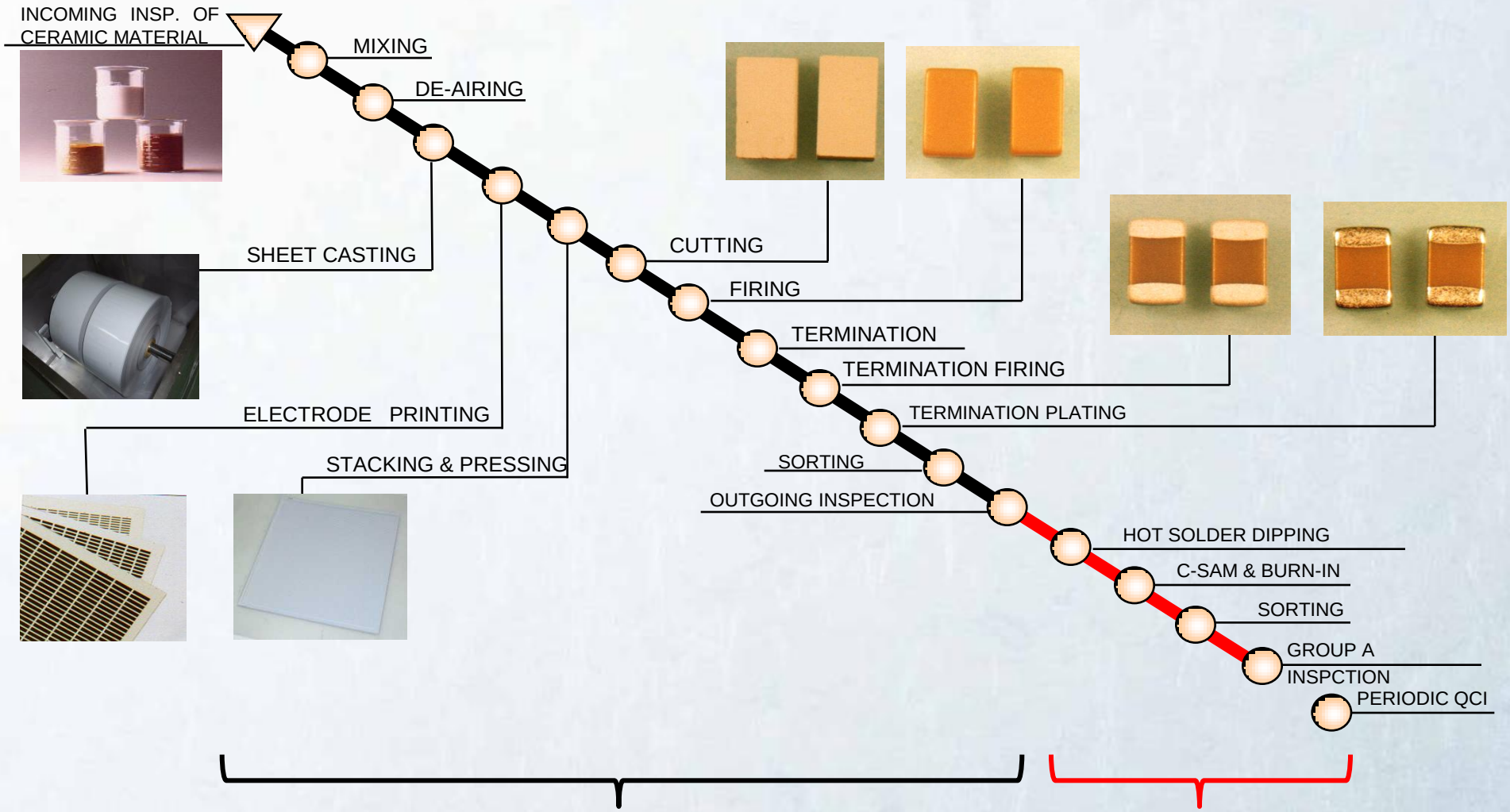
Space grade MLCC were based on automotive grade,
Added up-screening as C-SAM and BURN IN , hot solder dipping, and ratio voltage down to 1/2

Trends in capacitance per volume



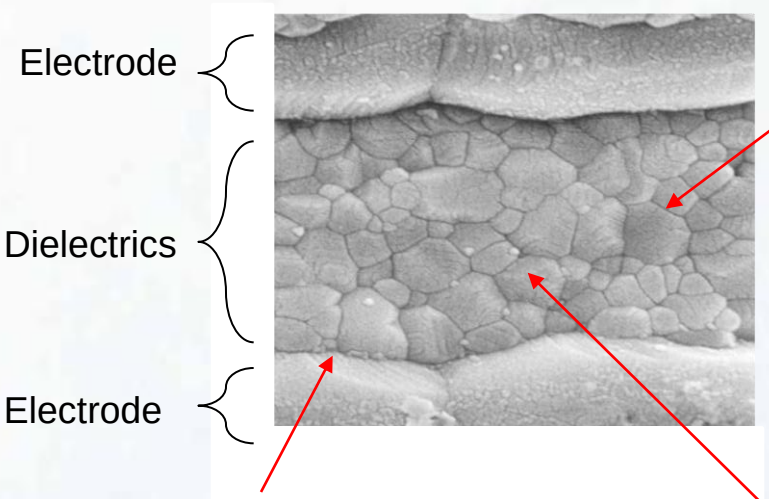
CONTENTS

CERAMIC CAPACITOR PROCESS



Technology of the microstructure

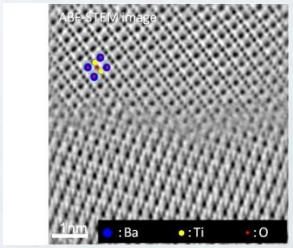
Pursuit for thinner dielectric layer

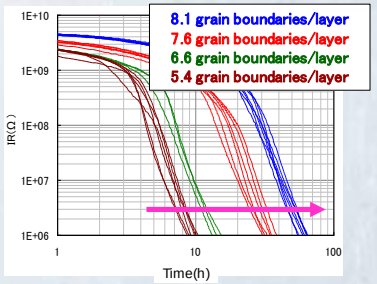


Grain boundary

・Keeping enough number of grain boundaries by reducing grain size

・To improve the performance of grain boundary

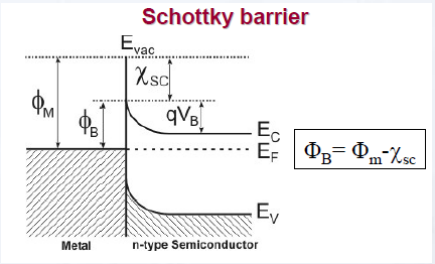


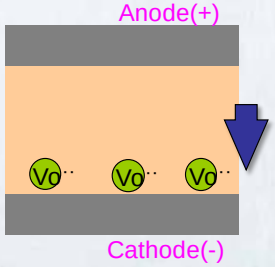


Electrode interface

・Control of the electron injection by the electrical barrier

・Critical oxygen vacancy accumulation

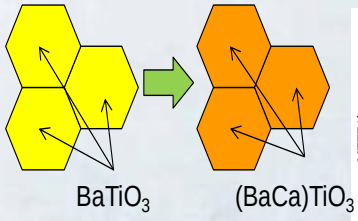


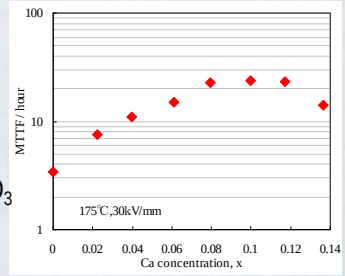


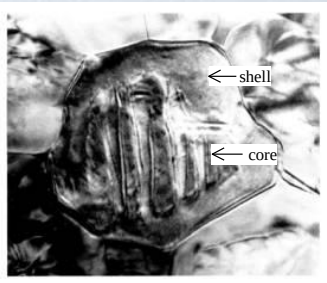
Grain interior

・Enhancing insulation characteristics of grain interior by doping

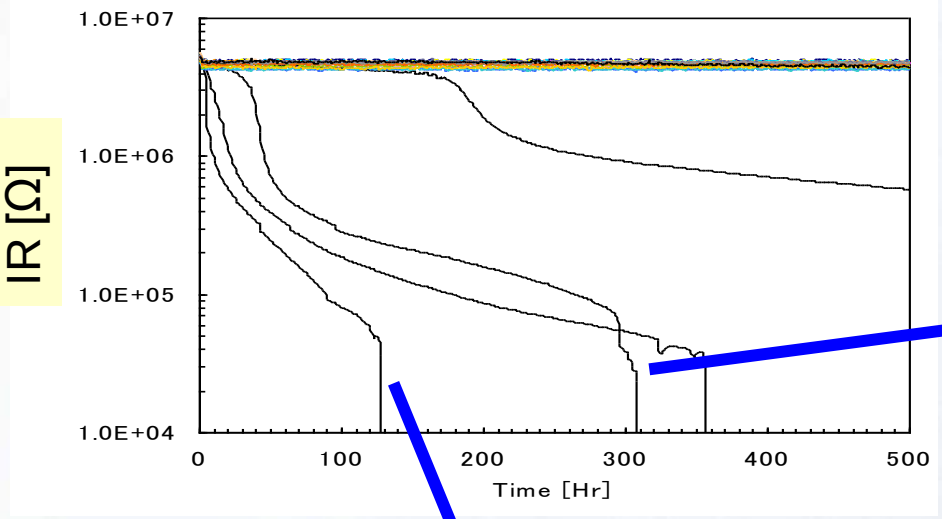
・Core-shell structure

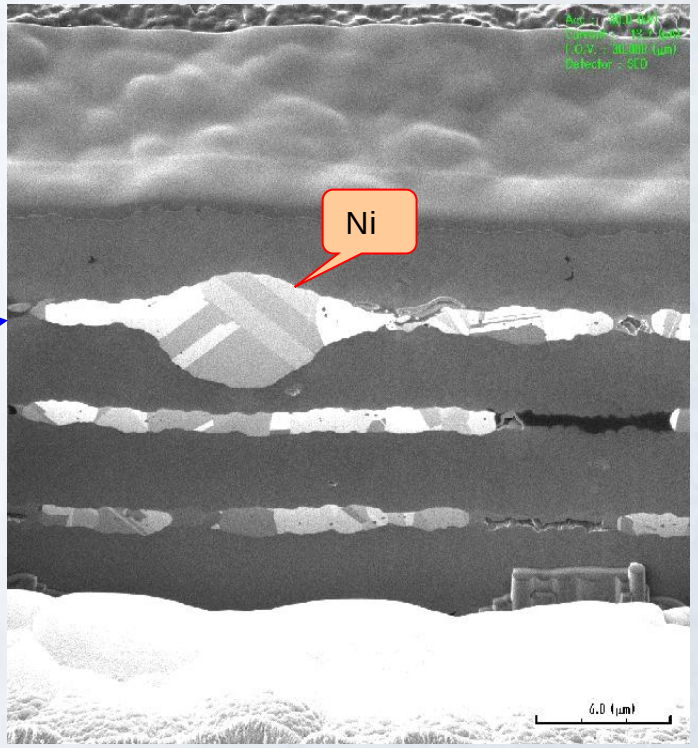


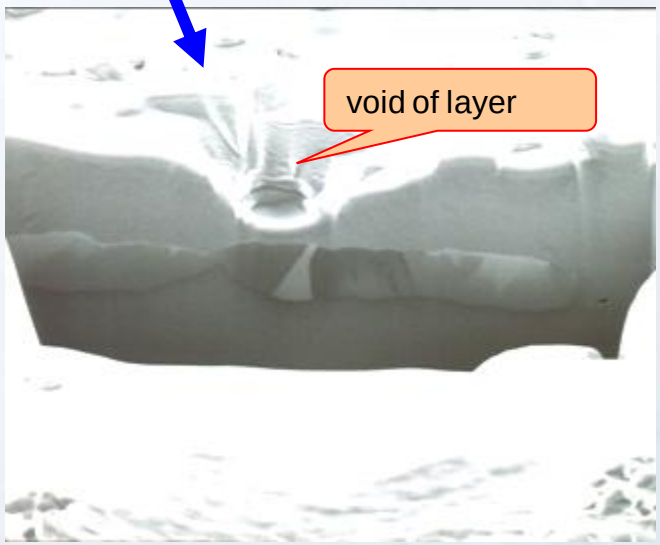




Analysis of IR degradation component

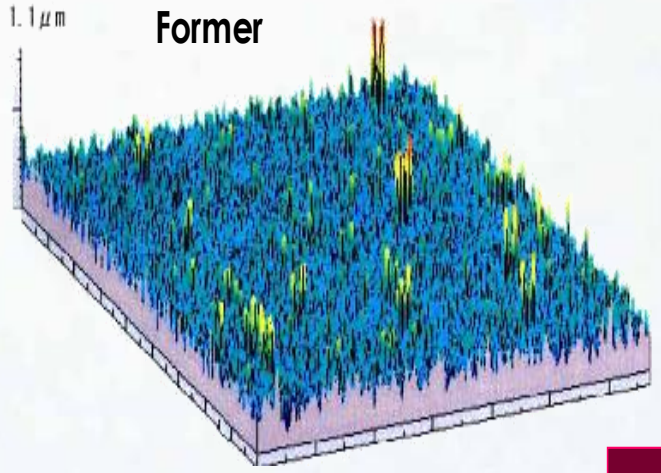


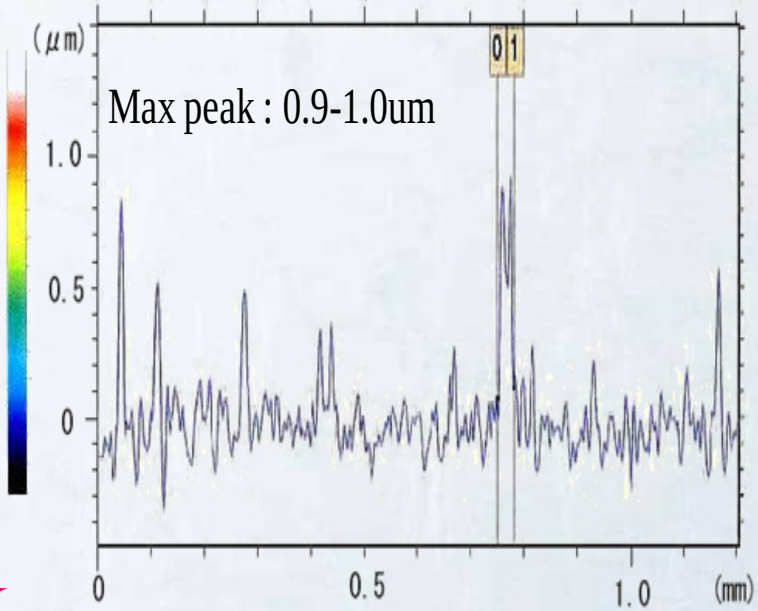


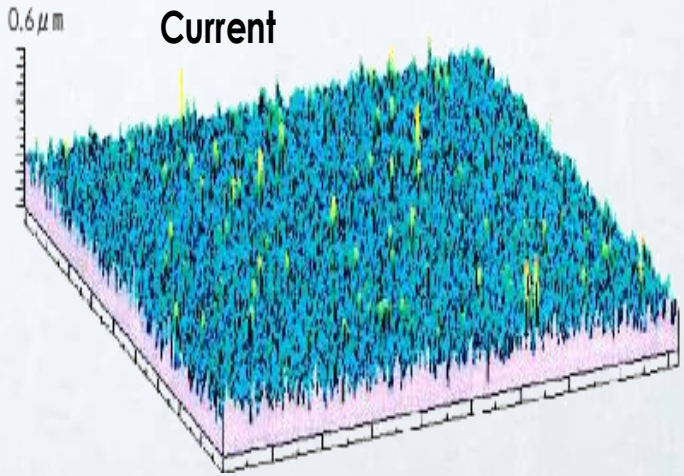


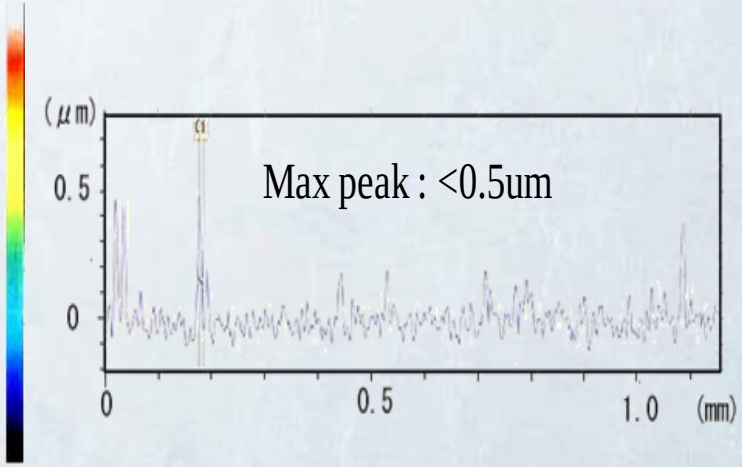
Degradation of IR is caused by mictro defective point of ceramics layer or inner electrode.

Uniformity of Composition



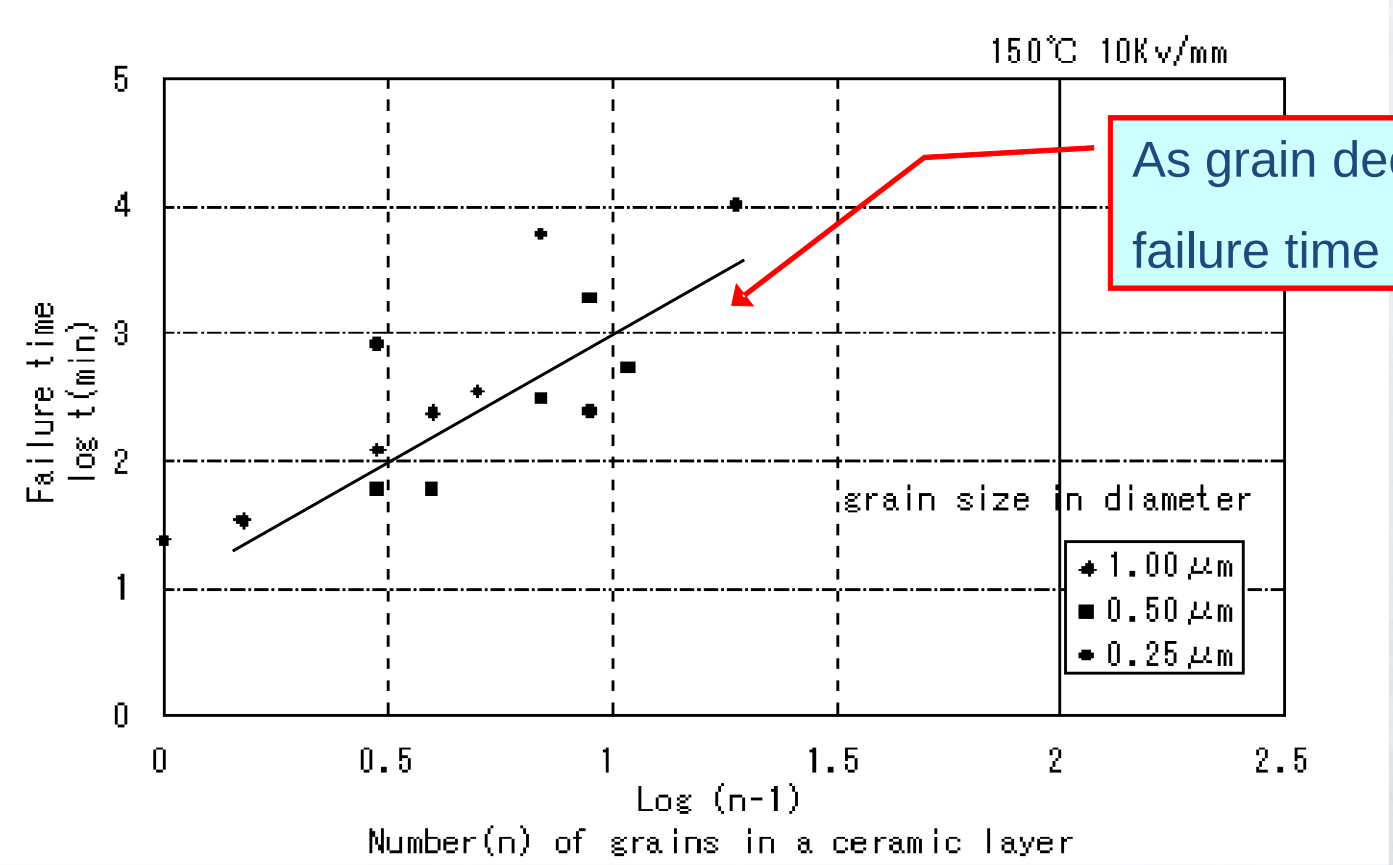






Surface roughness of inner electrode

Failure time vs number of grains

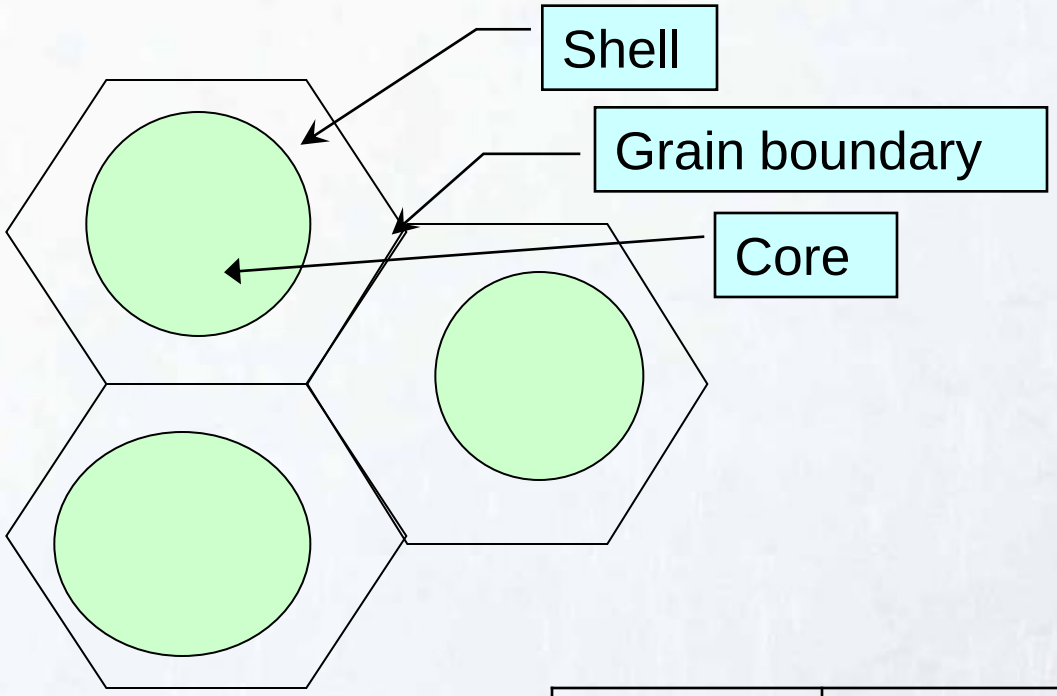


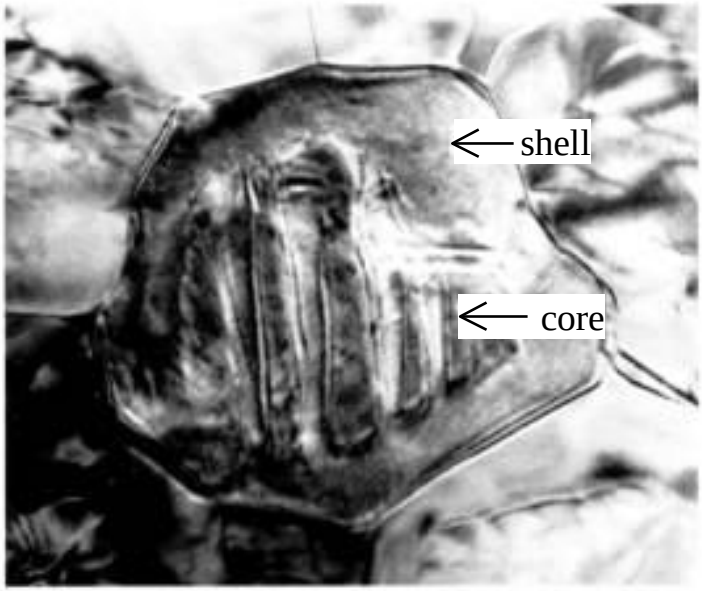
As grain decrease,

failure time is shorten.

component reliability have correlation with the number of ceramics

Core-Shell micro structure

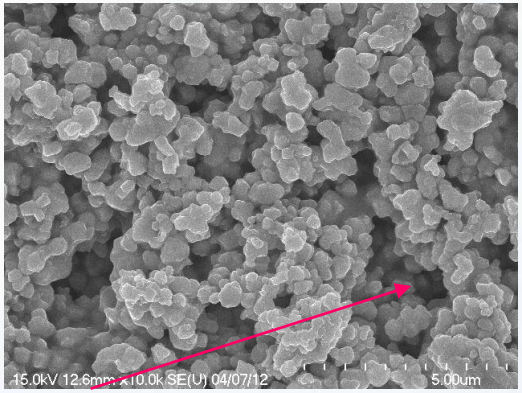


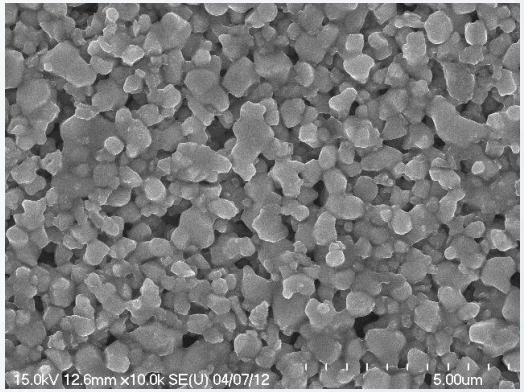


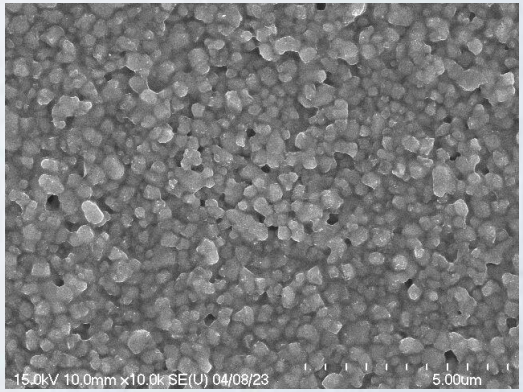
	Core	Shell	Boundary
ρ (Ωcm)	10^{11}	10^{13}	10^{14}

Thinner Shell ⇒ Low IR

Fine ceramic powder for increasing number of grain







Pore

Former

High density
Fine ceramic powder

Current

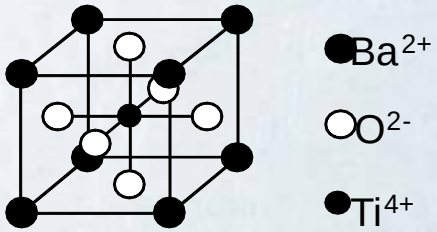
2um

FE-SEM: Surface of green film

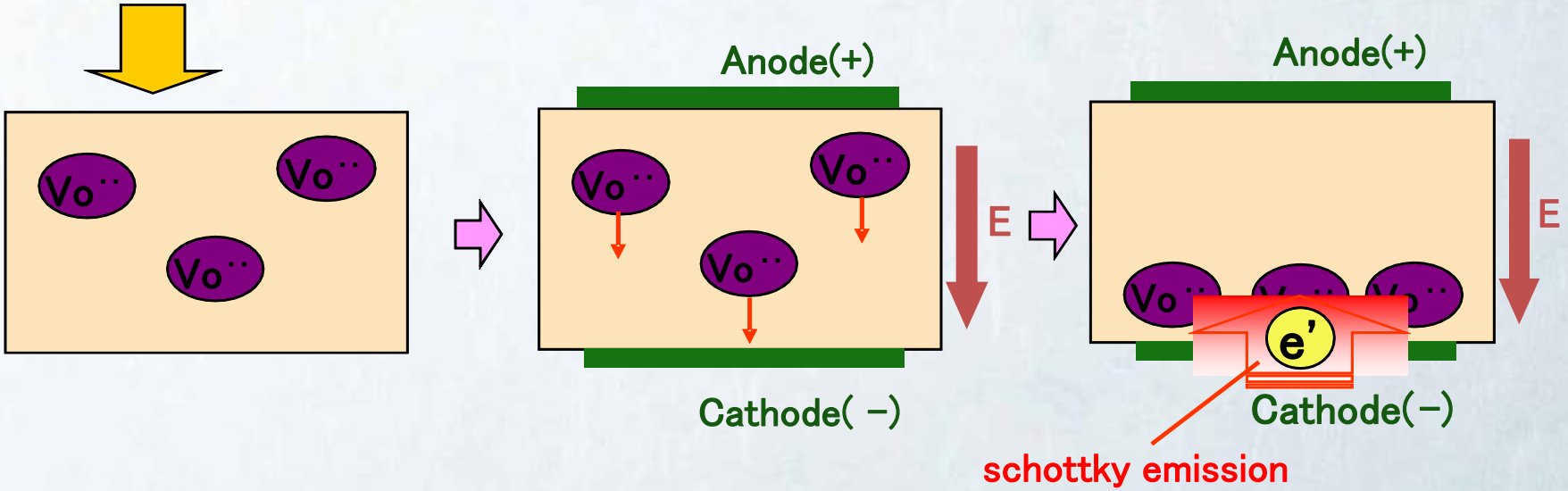
Improvement of micro structure to prolong wear-out

Base metal electrode → Need to fire under low O_2 atmosphere.

After firing, the oxygen vacancies are generated .
The oxygen vacancies have positive charge.



Crystal structures of Barium Titanate

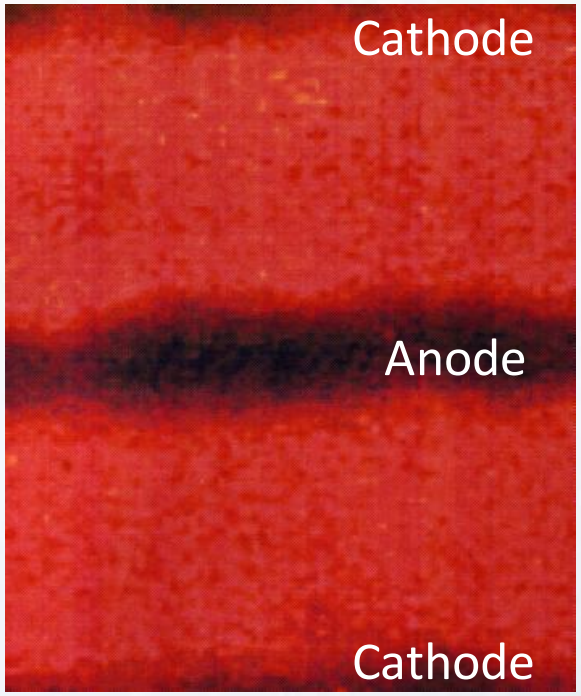


The cluster of oxygen vacancy generate schottky emission which result in ceramics degradation.
->Necessity to maintain dielectrics strength with material technology.

Mechanism of IR degradation under Electric field

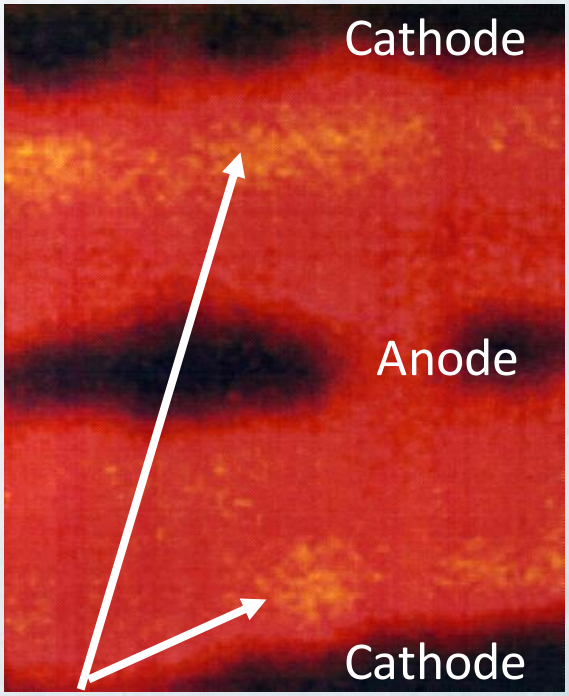
Analysis of oxygen vacancy distribution by Cathode Luminescence

Initial



Oxygen vacancies are distributed.
(There is no luminescence.)

After High Temp Load Test



Oxygen vacancies move to cathode.
(luminescence is observed.)

Test condition: 105deg.C, 10kV/mm, after 24 hours

Effect of suppressing oxygen vacancy ($V^{\cdot\cdot}_{O}$) movement by Rare earth doping (image view)

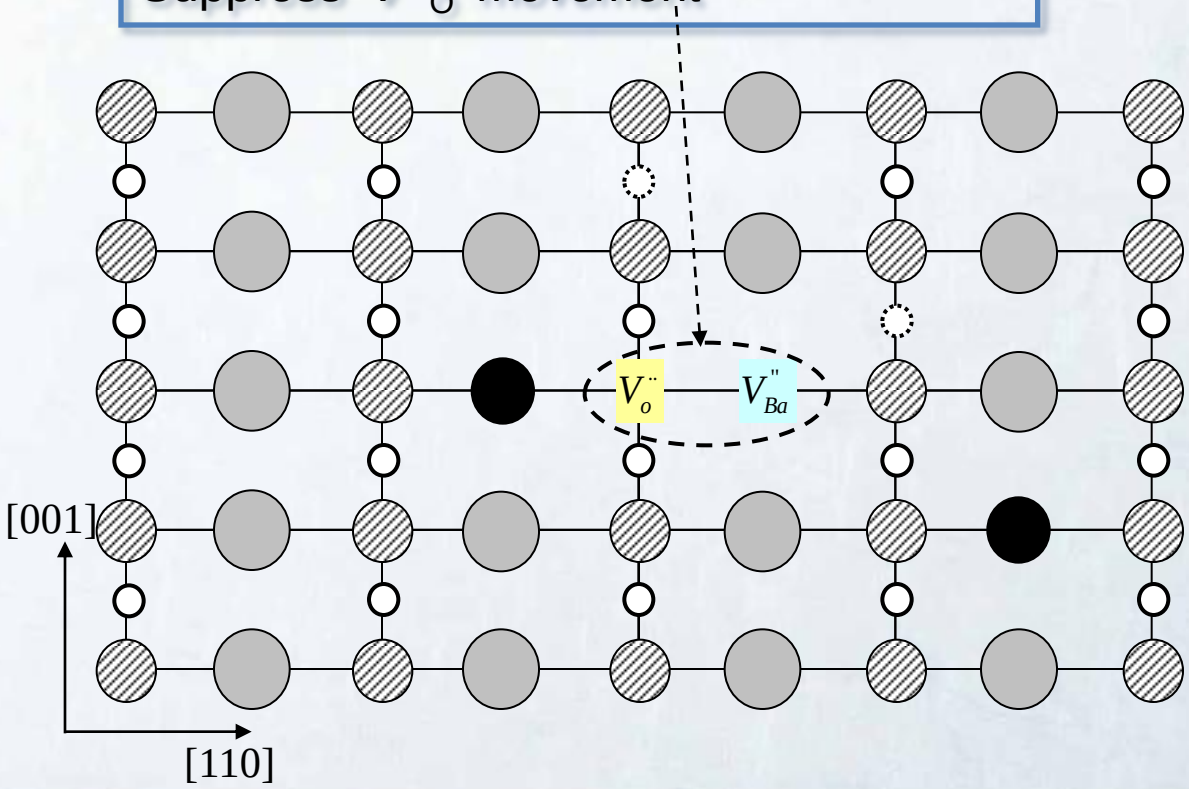
Doping rare earth for displacing Ba site

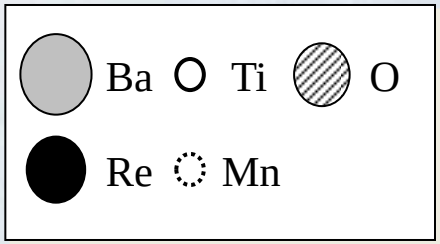
Generated barium vacancy (V''_{Ba})

Join $V^{\cdot\cdot}_{O}$ and V''_{Ba}

Suppress $V^{\cdot\cdot}_{O}$ movement

(image view)





⇒after high-temperature and high-electric field condition , oxygen vacancy move to cathode.

Conclusion

Technology for small size and high capacitance

1. Uniformity
   - inner electrode
   - high density sheet
   - ceramic grain

2. Control ceramic characteristic and grain boundary

3. Control firing reaction process and internal stress

4. The process technology without contamination and damage to elements (less than ppb order)

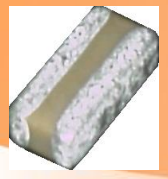
5. Development high ε material

CONTENTS

MURATA's MLCC products

★Accelerating Development for Small Case Size & Higher Capacitance Products★

Low ESL Capacitor
<LLL>
<NFM>



Normal MLCC
<GRM Hi-Capacitance>
<GRM02 GRM03>
<GRM Low

C-Array
<GNM>

Core Competence for Murata Technology

★New Line-up★

Wide Line Capacitor
<GW>

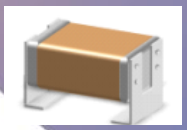
★FOR IC PACKAGE
<GRU>

High Q Capacitor
<GJM,GQM>

Micro Chip Capacitor
<GMA>

★New Line-up★

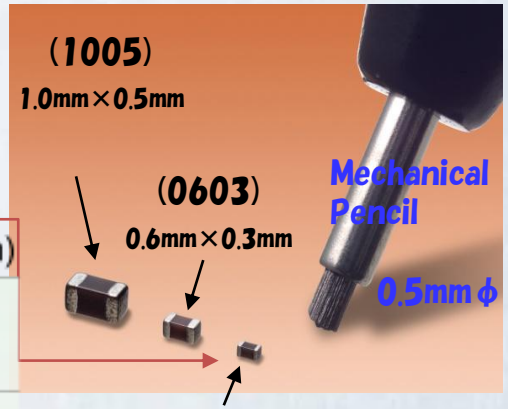
Low acoustic capacitor
<KRM>

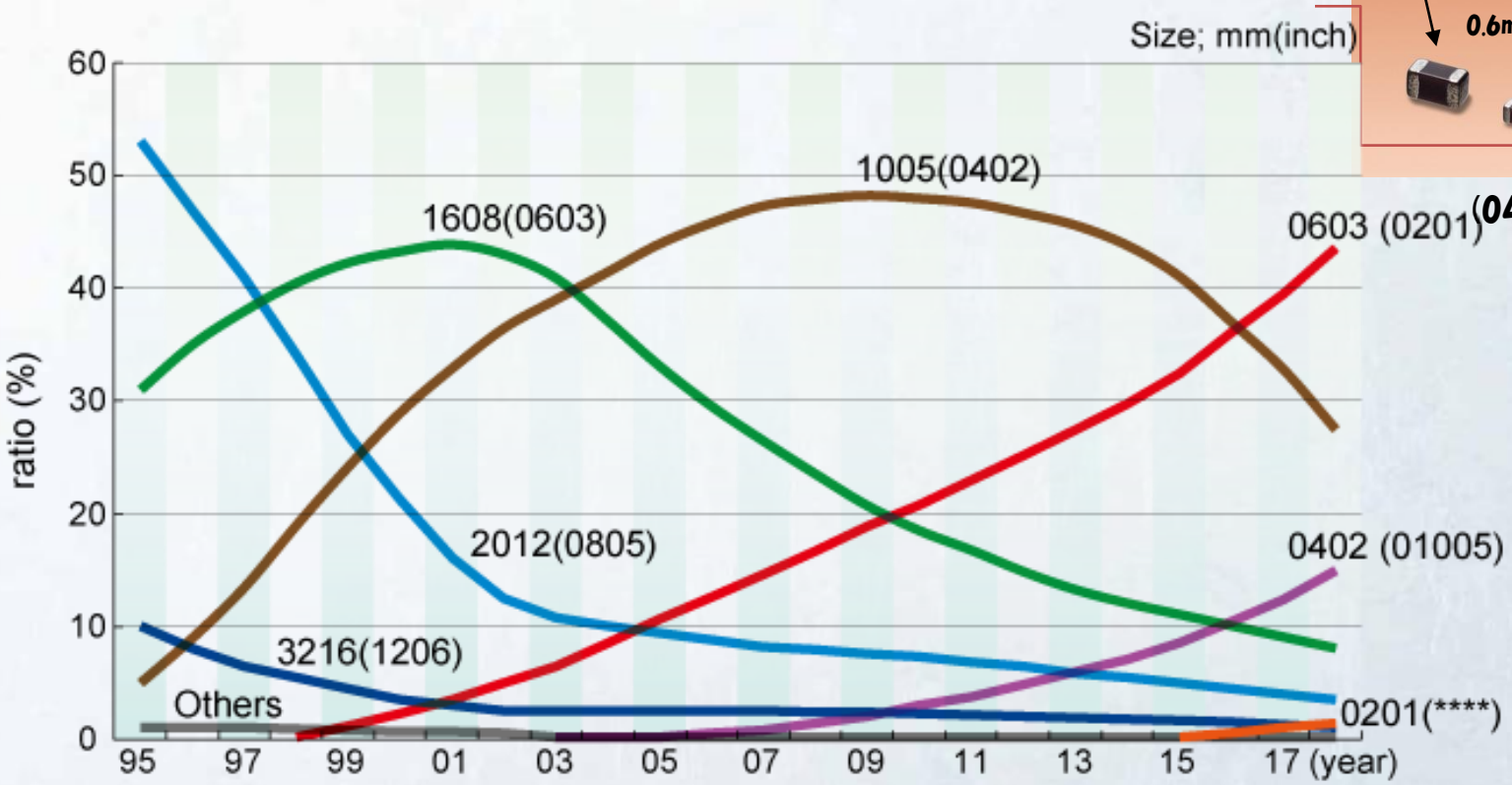


MLCC size trend

Rapid increase of smaller MLCC size is expected.

0603(0201) will be the major size after 2016.





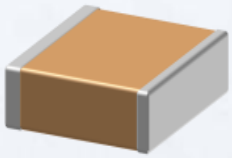
0402(01005) size demand increase, New size(0201) from 2015

For Automotive application

Small size , high capacitance, High voltage

Line-up expansion

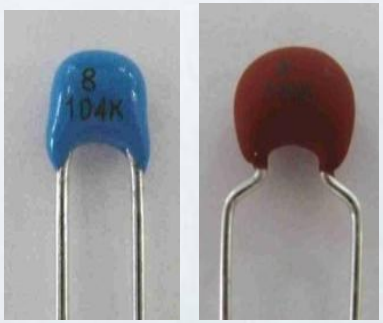
GCM series
X7R,U2J
DC250V – DC1kV
(DC2kV-3.15kV)
(Under evelopment)



High temperature

150℃ guarantee

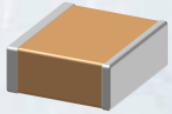
RHE/RHD series



Safety mounting

Soft termination Lead type

Soft termination
GCJ series



Lead type
KCM/KC3 series

Application specific capacitor

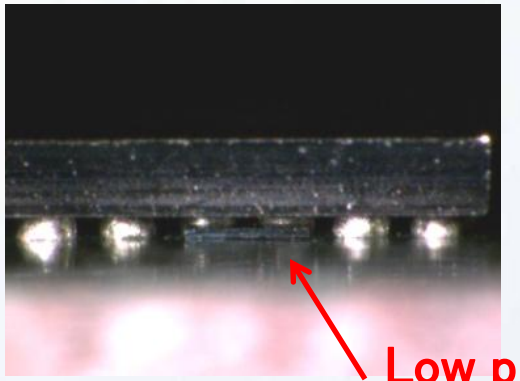
AC capacitor for PHEV/EV

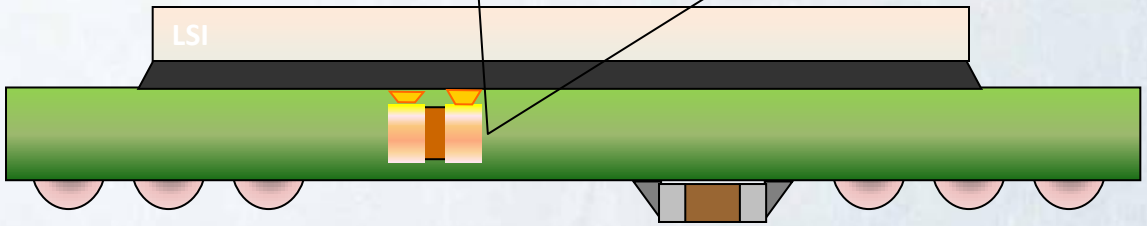
DE6 series

Under development for aero-space

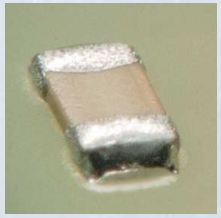
For IC package

Embedded Capacitor
-> Murata GRU series
(Thickness : 0.15/0.20/0.22/0.25/0.33mmMax)





Low profile cap(for Bottom side mounting)
-> Murata GRM15Y/GRM152/GRM153
(Thickness : 0.15, 0.22, 0.33mmMax)



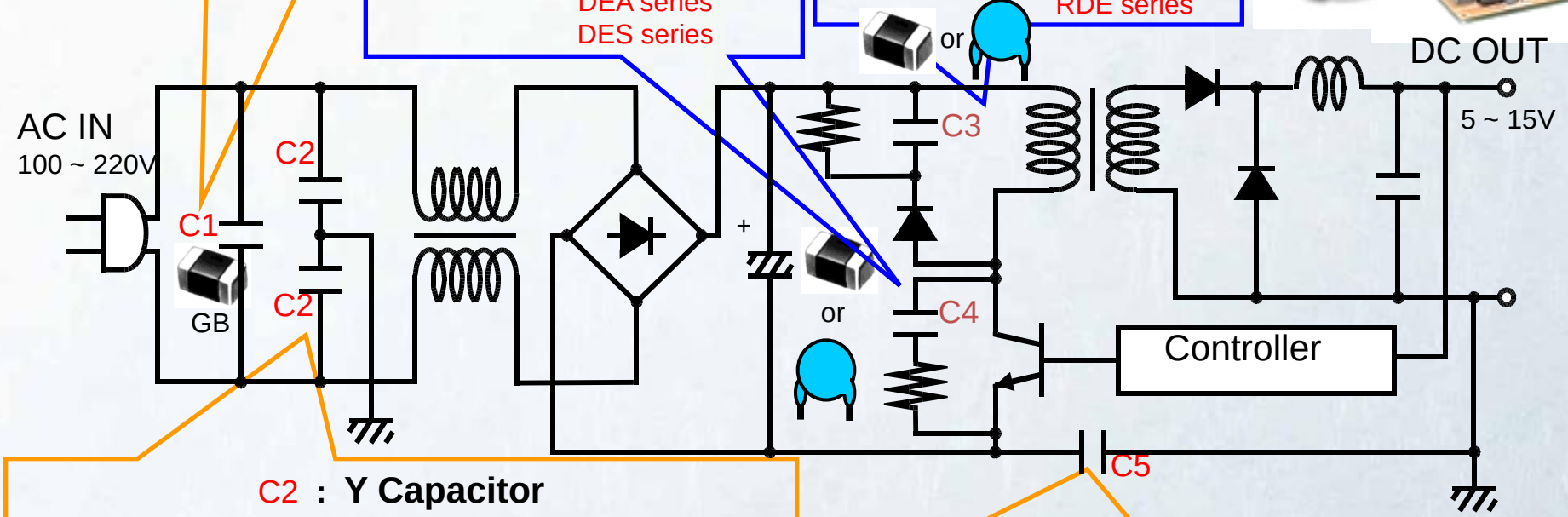
For Switching Power Supply ~ Class 2

muRata

C1 : X Capacitor
10~33nF/X2 x 1pcs
Chip : Type GB

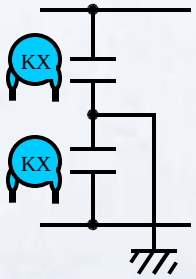
C4 : Snubber
100~1000pF/DC630~1kV x 1pcs
Chip : GRM/U2J
Lead : DEH series
DEA series
DES series

C3 : Snubber
1~220nF/DC250~630V x 1pcs
Chip : GRM/X7R
Lead : DEH,DES series
RDE series

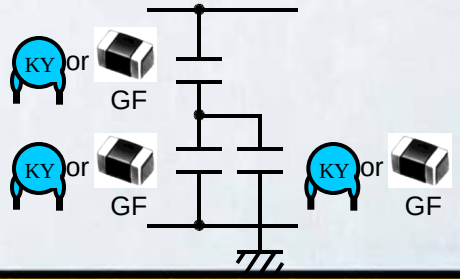


C2 : Y Capacitor

470~4700pF/Y1x 2pcs
Lead : Type KX

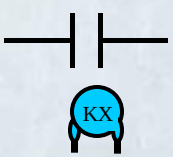


470~4700pF/Y2 x 3pcs
Lead : Type KY
Chip : Type GF



C5 : Primary - Secondary Isolation Capacitor

470~4700pF/Y1x 1pcs
Lead : Type KX



470~4700pF/Y2 x 2pcs
Lead : Type KY
Chip : Type GF

Low ESR(High Q) / Low ESL capacitor

Low ESR(High Q)

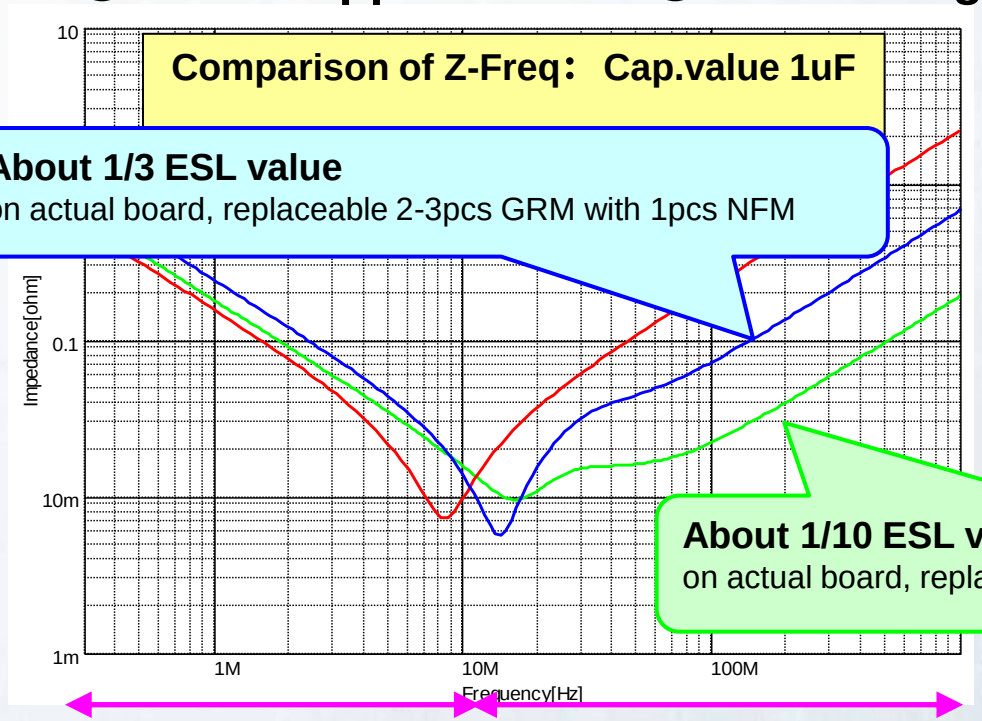
Same configuratuon

GJM 500MHz～10GHz Cap.≧30pF：Q≧1000

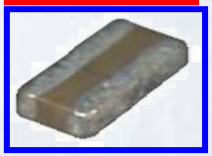
GQM 500MHz～10GHz Cap ≧30pF：Q≧1400

Low ESL【Merit】

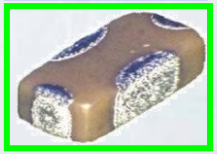
①Noise suppression ②Downsizing ③Cost down



General type
（GRM155B31A105KE15）



Reversed geometry type
（LLL185C70J105ME14）



3terminal type
（NFM18PS105R0J3）

MURATA HP & CONTACT PERSONS

http://www.murata.co.jp/

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Please access MURATA Web.
If you have any questions , contact to MURATA's sales friendly anytime.

MURATA will strive to become

your most reliable partner

by offering value-added capacitors

We have “ O MO TE NA SHI ” mind.

Thank you for your attention