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50MV/m recipe for ICHIRO end groups with ethanol rinsing and wiping

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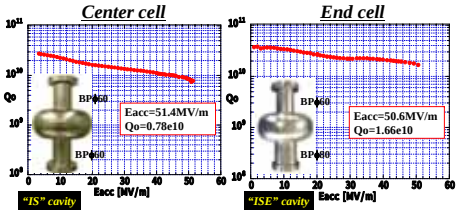
See poster THPPO090 for more details about sulphur.
"Sulfur Generation Mechanism During Electropolishing with Niobium Cavities"

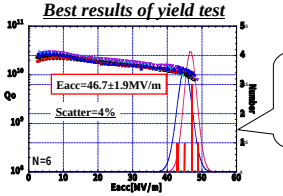
ICHIRO single cell cavities w/ simple beam tube

Proof of principle for 50MV/m was done with ICHIRO singles that have simple beam tube, but no end groups.
Center and end cell shape have no problem for RF structure.



We established high yield recipe for 50MV/m, KEK-LL recipe.
Best recipe for simple BP singles was
"CBP+CP+AN+EP(80μm)+EP(20μm)+flash EP(3μm)+HPR+Bake".

Best results of yield test



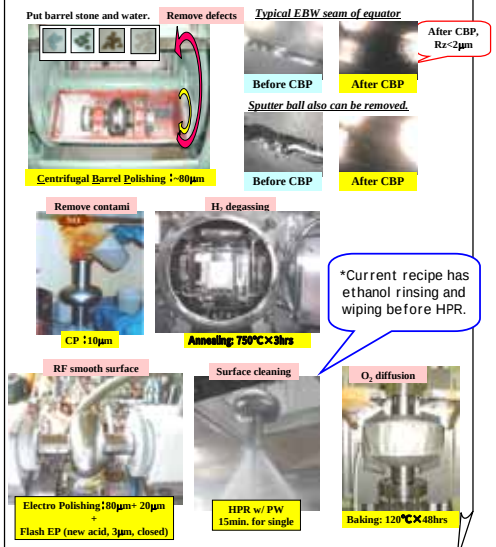
This results satisfied ACD goal of Qo>0.8e10 @ 40MV/m and 45MV/m +-5% scatter shown w/ blue line in plots.

6 IS cavities were used for yield test.

+

CBP+CP+AN+EP(80μm)+EP(20μm)+flash EP(3μm)+HPR+Bake

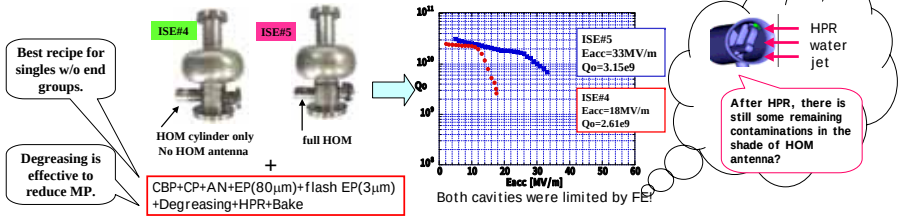
We are still trying to improve our KEK-LL recipe.
High reliability, High performance, Low cost, Simple process.



*Current recipe has ethanol rinsing and wiping before HPR.

ICHIRO single cell cavities w/ end groups

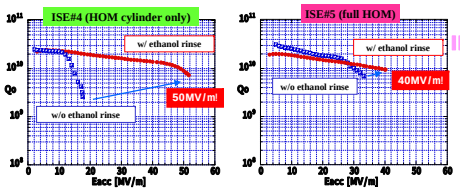
We started pilot study of end single cell cavities with end groups to focus on the problems of those.
Best recipe for singles w/o end groups didn't work well for singles w/ end groups.
Additional degreasing and HPR had no cure for these results,



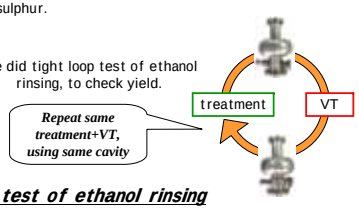
Both cavities were limited by FE!

End groups have complicate structures, so we suspected degreasing and HPR were not enough to remove sulphur contaminations.
To strengthen the rinsing after EP process, we tried ethanol rinsing which can dissolve sulphur.
Ethanol rinsing worked well. ISE#4 and ISE#5 achieved 40~50MV/m!

Pilot study of ethanol rinsing



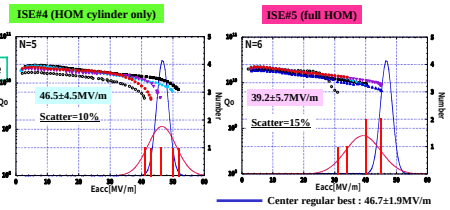
We did tight loop test of ethanol rinsing, to check yield.



Repeat same treatment+VT, using same cavity

Recipe: +EP(20μm)+flash EP(3μm) +Ethanol rinsing+Degreasing+HPR+Bake

Tight loop test of ethanol rinsing

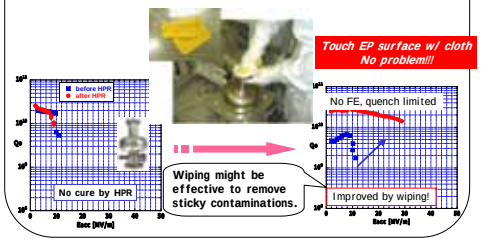


Recipe:+EP(20μm)+flash EP(3μm)+Ethanol rinsing+Degreasing+HPR+Bake

ISE#4, Q-slope became clear even though cavity were baked.
ISE#5 was limited at 45MV/m.
Scatter were larger than singles w/o end groups.

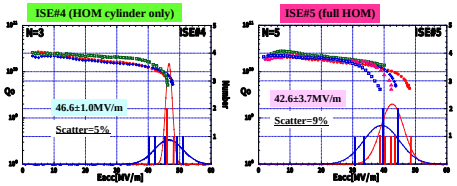
Wiping w/ degreaser

We tried aggressive rinsing "Wiping".
EP'ed cavity surface were wiped by smooth cloth and degreaser.



We applied wiping on 9-cell cavities.
See poster THUPO082.

Tight loop test of Wiping

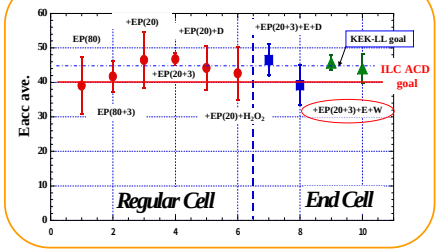


Recipe:+EP(20μm)+flash EP(3μm)+Ethanol rinsing+Wiping+HPR+Bake

We did tight loop test of EP+Ethanol rinse+Wiping.
Full HOM cavity, ISE#5 achieved 48MV/m, Q-slope became very clear.
Scatter of gradient became narrow. Eacc and Q value were also improved.
Wiping was very effective to reproducibility, but had no cure of high field Q-slope.

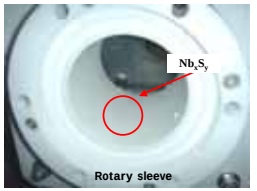
	EP+Ethanol		EP+Ethanol+Wiping	
	Eacc max	Qo@40MV/m	Eacc max	Qo`40MV/m
ISE#4	46.5±4.5MV/m	1.15±0.22e10	46.6±1.0MV/m	1.37±0.22e10
ISE#5	39.2±5.7MV/m	0.97±0.11e10	42.6±3.7MV/m	1.12±0.21e10

Comparison of recipe



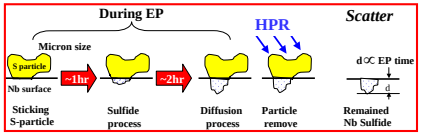
Sulphur contaminations

After our EP process at Nomura, sulfur was found on cathode bag and rotary sleeve.

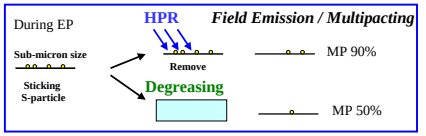


Mechanism of sulphur contaminations.

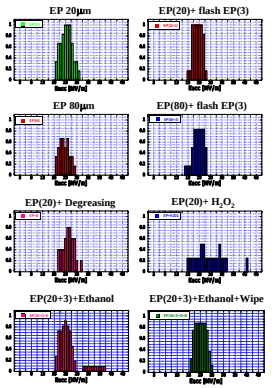
1. Scatter

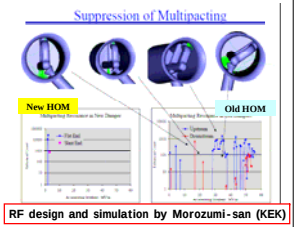


2. MP and FE



Multipacting on Single Cell Cavities





RF design and simulation by Morozumi-san (KEK)

All recipe showed MP around 17~25MV/m or more.
Need to establish MP free recipe, or eliminate sulphur generation.

Summary

There is no problem of the RF structure neither ICHIRO regular cell or end cell.
Proof of principle for 50MV/m was done.

End groups have complex structures, so need more effective and strong rinsing.
Only degreasing + HPR are not enough for end groups.

Ethanol rinsing and wiping are effective to remove sticky contaminations at complex end groups.

Wiping has no problem for EP surface so far, but doesn't cure high field Q-slope.

Current best recipe for single cell cavities:

CBP+CP+EP(80+20mm)+flash EP(3mm)+Ethanol rinsing+Wiping+HPR+Baking.

Remaining subjects with single cells are
*achieve 50MV/m with full end group single.
*cure high field Q-slope.