

Nb Single-cell Cavity Vertical Electro-polishing with Ninja Cathode and Evaluation of its Accelerating Gradient

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Marui Galvanizing Co. Ltd. has been improving Vertical Electro-Polishing (VEP) technology for Nb superconducting RF cavity in collaboration with KEK. In this collaboration, we developed a unique cathode namely "Ninja cathode" for VEP treatment of Nb cavities. We have already reported that longitudinal symmetry in niobium removal and surface state of a single cell cavity were improved after VEP using the Ninja cathode. In this article, we report a result of accelerating gradient evaluation for 1.3 GHz single cell RF cavity after VEP with Ninja cathode in collaboration with KEK and CEA Saclay.

Introduction

- Marui Galvanizing Co., Ltd. developed original "Ninja" cathode for VEP in collaboration with KEK.
- Polished surface and removal thickness distribution after VEP with Ninja cathode are improved.

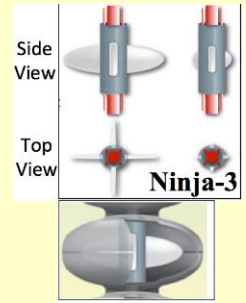


To apply VEP for cavity mass production, accelerating gradient evaluation after VEP with Ninja cathode is required.



Single-cell cavity VEP with Ninja cathode and accelerating gradient evaluation were performed in collaboration with Marui-KEK-CEA Saclay.

Ninja cathode and VEP setup



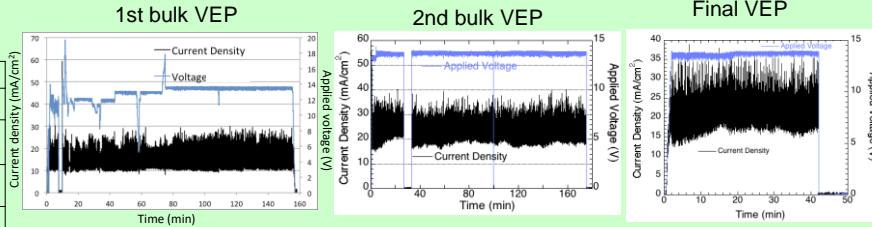
- CEA Saclay's single-cell cavity was VEPed with Ninja cathode using Marui's VEP facility.
- Anneal and HPR were performed in KEK and vertical test was performed in CEA Saclay.
- Bulk VEP1 → Status confirmation → Bulk VEP2 → Status confirmation → Anneal → Final VEP → HPR → Vertical test was the process of this experiment.

VEP experiment and VT result

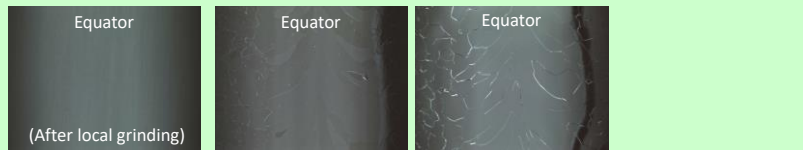
VEP condition

	1st bulk VEP	2nd bulk VEP	Annealing	Final VEP
Voltage	12 – 14 V	12 – 14 V	750 degC 3 hours	12 – 14 V
Current density	10 – 20 mA/cm ²	20 – 30 mA/cm ²		15 – 25 mA/cm ²
Cavity surface temperature	14 – 17 degC	21 – 24 degC		21 – 24 degC
Cathode rotation speed	30 rpm	30 rpm		30 rpm
EP acid flow rate	3 – 5 L/min	2 – 4 L/min		2 – 4 L/min
EP time	Around 2.5 h	Around 2.5 h		Around 40 min
Average removal thickness (From weight loss)	Around 31 μm	Around 55 μm		Around 12 μm

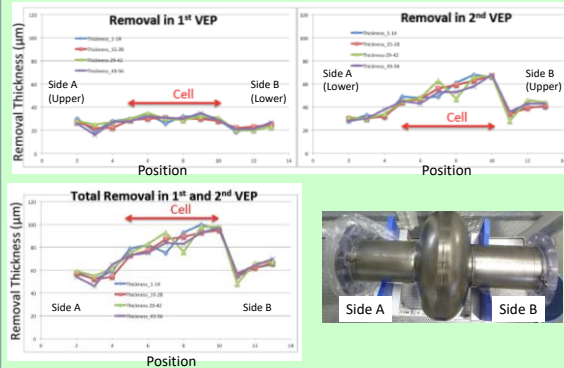
Voltage, current density during VEP



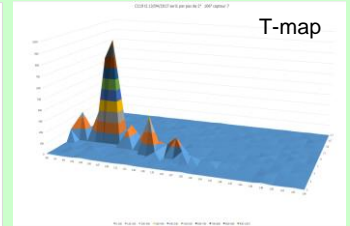
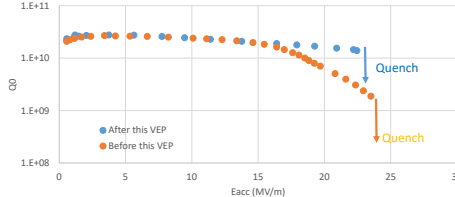
Cavity inner surface inspection results (Upper: digital camera, Lower: Kyoto camera)



Removal thickness distribution



Vertical test



- Voltage and current density are almost the same as usual Ninja VEP.
- The surface after each VEP was shiny so good state.
- Removal thickness distribution after 1st VEP was uniform, however after 2nd VEP was not uniform (upper side was larger).
- Accelerating gradient (Eacc) after VEP was 22.5MV/m and Q value was 1.3E10 (@1.6k), finally quench happened.
- After VEP, Q value was improved, however Eacc was almost same.
- One main hot spot was found from T-map measurement.

Summary

CEA Saclay's single-cell cavity was VEPed with Ninja cathode using Marui's VEP facility.

Eacc was 22.5MV/m and Q value was 1.3E10, finally quench happened. After VEP, Q value was improved, however Eacc was almost same.

Next step...

- Investigation of the cause of low Eacc quench.
- Remove this cause and VEP, VT again.
- VEP with Ninja cathode using Saclay's VEP facility.