ISBN: 978-3-95450-211-0 doi:10.18429/JACoW-SRF2019-MOP062

FABRICATION OF SRF CAVITY

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Abstract

Mitsubishi Heavy industries Machinery System (MHI-MS) have developed manufacturing process of superconducting cavities for a long time. In this presentation, recent progress is reported.

INTRODUCTION

MHI-MS has supplied the superconducting RF cavities and the cryomodules for various electron accelerator projects, such as a STF and c-ERL project at KEK [1] since 1977. Moreover, MHI-MS supplied 73MHz superconducting quarter-wavelength resonator (QWR) for superconducting linear ion accelerator project for RIKEN Nishina Center.

Meanwhile, MHI-MS have been contributing to study the various vacuum seal methods with KEK. MHI-MS presented regarding the development plan of changing from the bolts jointed seal to the quick coupling seal in SRF2013. In this paper, MHI-MS report the progress of the joint research of the quick coupling seal with KEK.

DEVELOPMENT OF FLANGE SEALING

MHI-MS have designed and fabricated some kind of the flanges for SRF cavities with the cooperation of KEK. In this section, we introduced some flanges which had been manufactured and adopted for SRF cavities.

TEST FOR QUICK COUPLING SEAL

MHI-MS have been testing for the quick coupling seal in the joint research with KEK. We estimate this seal enable to decrease time the cavity is open during the assembly of the cavities and reduce the risk of the contamination. Our future plan of the pick-up port with the quick coupling seal is shown in Figure 1 which MHI-MS presented in SRF2013 [2].

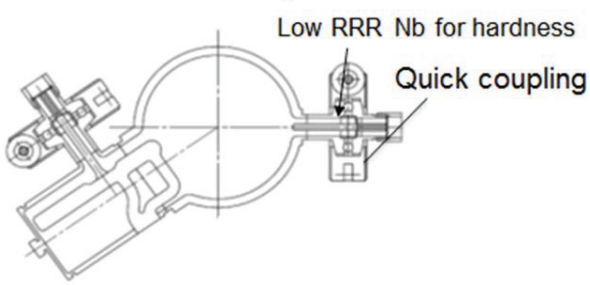

Figure 1: Future plan of the pick-up port with the quick coupling seal.

The specification satisfies the requests for the cryogenic temperature seal of SRF cavities. This quick coupling seal is composed of the aluminium edge seal and the stainless steel clump. The acceptable operating temperature of the seal and the clump is -270degC to +150degC and -270degC to +350degC. The pressure limit is $<10^{-9}$Pa. We selected NW16 and NW40 for this test.

Preparations for the Heat Cycle Test

The heat cycle test for the quick coupling seal was performed using the vacuum vessel which has the NbTi flanges and the Nb beam pipe, the NbTi blank flanges and the SUS316L cross pipe. (See Figure 2).

Figure 2: Preparations for the heat cycle test.

Procedure of the Clumping

The procedure of clumping is shown in Figure 3. It is possible to assemble quickly. For tool reason, we selected the tightening torque 4[N・m] (Standard torque:2.5[N・m]) for NW16. The tighten torque for NW40 flange is the standard torque 4.5[N・m].

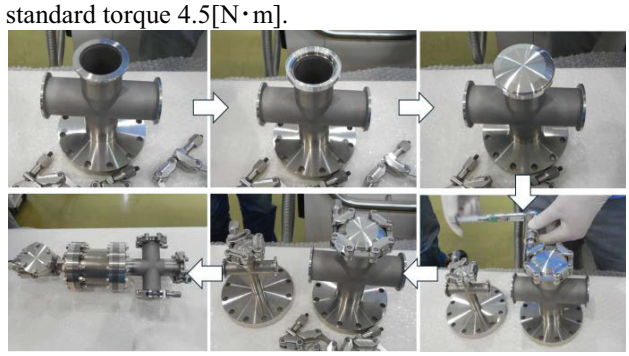

Figure 3: Procedure of the clumping.

Procedure of the Heat Cycle Test

The procedure of the heat cycle test is consisted of 3 steps. Firstly, the vacuum vessel sealed by the quick coupling is immersed in LN2 for 30min. Then, the vessel is heated by a heat gun. After the temperature rising to the room temperature, the helium leakage test is performed. (See Figure 4).

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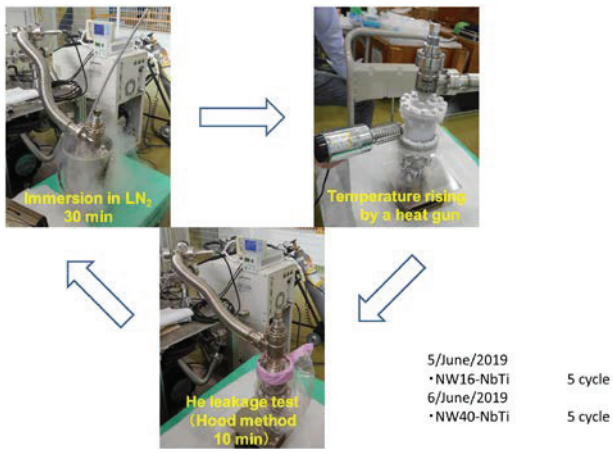

Figure 4: Procedure of the heat cycle test.

Five Times Heat Cycle Test

The five times heat cycle test was carried out for the NW 16 and NW40 blank flanges made of NbTi. The results of the helium leak rate are shown in Figure 5 and 6, and the results of the vacuum degree are shown in Figure 7 and 8 during the five times heat cycle test. No helium leak was found. However, there was the deterioration of the vacuum degree after the first heat cycle in the test for NW40. Therefore, the flange was tightened additionally after the third heat cycle test and found the vacuum degree recovered.

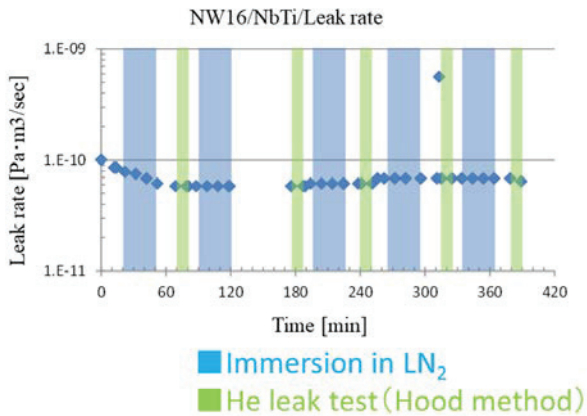

Figure 5: Result of helium leak rate (NW16).

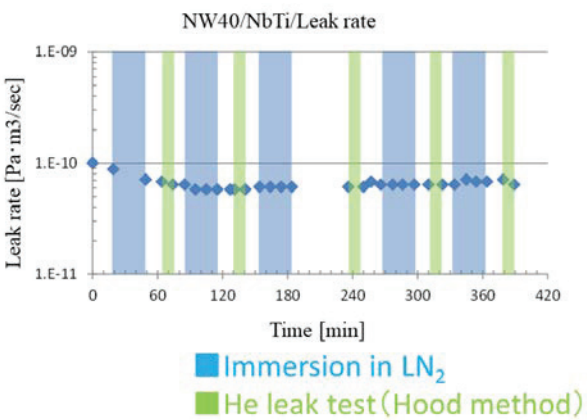

Figure 6: Result of helium leak rate (NW40).

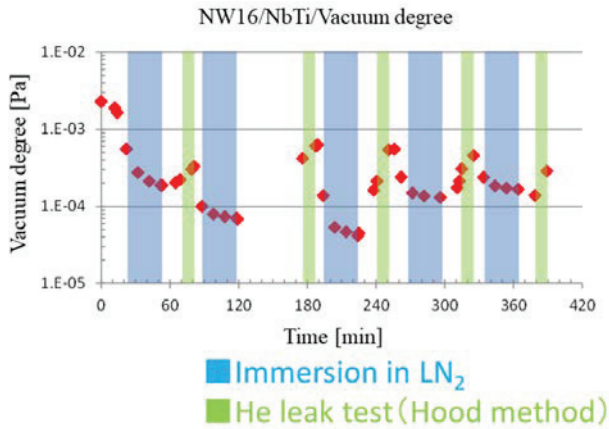

Figure 7: Result of Vacuum degree (NW16).

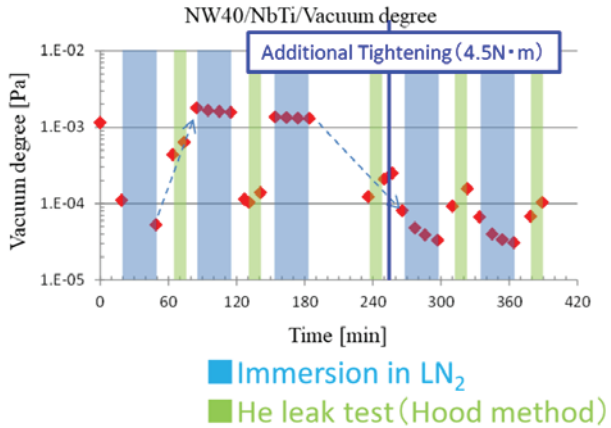

Figure 8: Result of Vacuum degree (NW40).

Flange and Seal after the Heat Cycle Test

After the heat cycle test, the flange and the seal are disassembled. There are no deformation, depression and aluminium remaining visually on the flanges. (See Figure 9). The edge of the aluminium seal have the tendency which indicate the clumping bolt side is strongly pressed. (See Figure 10).

Figure 9: NbTi blank flange (NW16) after of the test.

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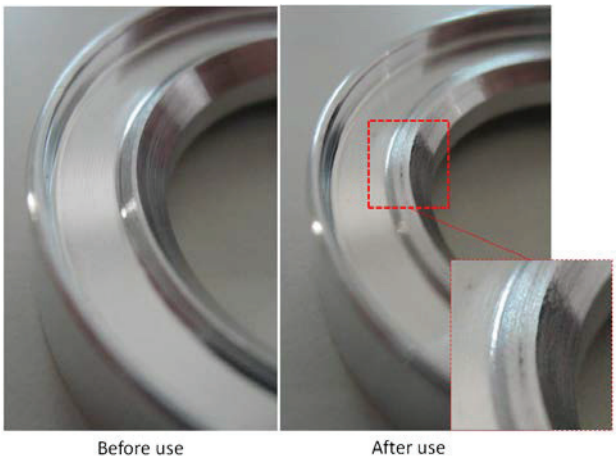

Figure 10: Aluminium edge seal (Before and before use).

CONCLUSION

Our recent progress of the joint research for the quick coupling seal with KEK is reported in this paper.

- No helium leakage was found from the quick coupling seal after the heat cycle test.
- There was the deterioration of the vacuum degree after the first heat cycle in the test for NbTi flange. The vacuum degree recovered after the additional tightening.
- There are no deformation, depression and aluminium remaining visually on the flanges.

FUTURE PLAN

MHI-MS is performing the heat cycle test by using Liquid helium for cooling with KEK (Figure 11).

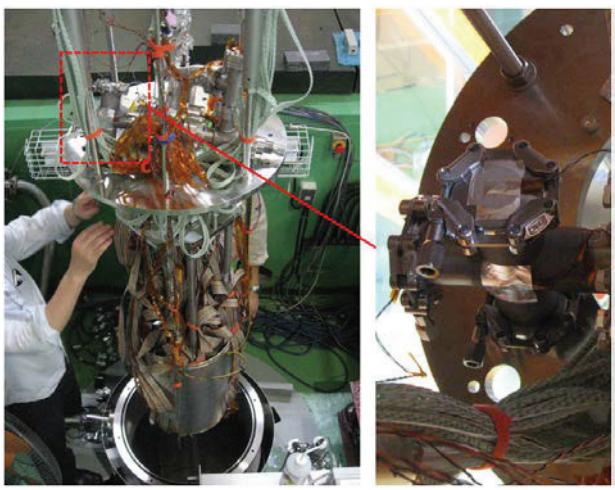

Figure 11: Test flanges installed into the helium vessel.

MHI-MS is planning following researches with KEK.

- Heat cycle test by using other material flanges (e.g., Gr-2 Niobium flange applied to QWR for SRILAC in RIKEN RIBF)
- Heat cycle test by using other size flanges (e.g., NW80 flange)
- Measurement of the particle during the work of clumping and dismantle
- Study for Semi-automatic clump works
- Study for the application to HPR and Baking

ACKNOWLEDGEMENTS

We acknowledge the support of KEK for the joint research of the quick coupling seal with KEK.

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[2] T. Yanagisawa *et al.,* "Status of the Superconducting Cavity Development for ILC", *in Proc. SRF2013,* Paris, France, Sep. 2013, paper MOP055, pp. 247-249.