Design of input coupler for RIKEN superconducting quarter-wavelength resonator

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At the RIKEN Nishina Center, the construction of an accelerator system based on the superconducting quarter-wavelength resonator (QWR) is underway as a prototype with the goal of developing basic technologies for the superconducting linear accelerator for ions.[1] For the heat flows that stem from the input coupler, the residual resistivity ratio (RRR) of the copper plating on the input coupler has an opposite influence on the dynamic loss and thermal conduction (for higher/lower RRR, lower/higher dynamic loss and higher/lower thermal conduction, respectively). The discussion on the minimization of heat flows into the cavity and thermal shield had suggested that a relatively low RRR (5-20) is preferable, and the cold window should be as close to the cavity as possible.[2]

In the above study, the thickness of the copper plating was fixed at 20 μm. However, as shown in Fig. 1, it was found that the RRR of the copper plating changed depending on the thickness of the copper plating. Therefore, we determined the optimal thickness of the copper plating. Figure 2 shows the heat flows into the cavity estimated for various sets of thickness and RRR of the copper plating, which were derived by the linear fitting of measured RRR data.

Because a realizable cold-window position was decided by the actual configuration of the coupler (13.5 mm), the heat flows into cavity with the realizable cold-window position were compared. Figure 3 suggests the optimum thickness of the copper plating to be 25-30 μm. However, the RRR for 25 μm adopted in this estimation seems to have less certainty. An actual RRR for 25 μm may be lower than that obtained by linear fitting (See Fig. 1). In that case, the heat flow into the cavity becomes larger than the estimated value. Therefore, we decided to set the thickness of the copper plating to 30 μm.

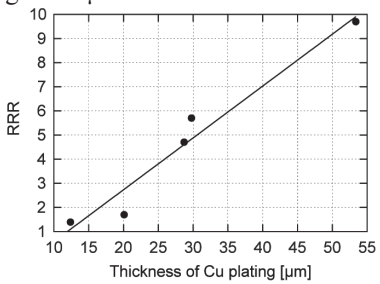

Fig. 1. Measured RRRs of copper plating for various thicknesses of copper plating. The solid line shows the result of linear fitting.

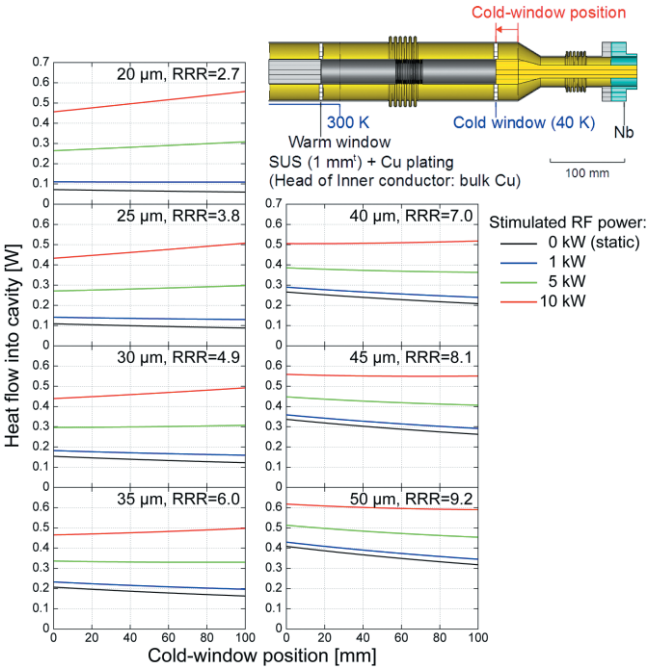

Fig. 2. Heat flows into the cavity as a function of cold-window position for various sets of thickness and RRR of copper plating. The configuration of the input coupler and the definition of cold-window position are also shown.

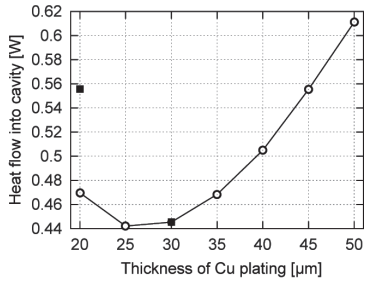

Fig. 3. Heat flows into the cavity for various thicknesses of copper plating (open circle) with realizable cold-window position. Stimulated RF power is 10 kW. As a reference, heat flows based on measured RRRs are also shown (filled square).

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References

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2) K. Ozeki et al.: Proc. of SRF2015, THPB084 (2015).

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