BRAZING AND HELIUM LEAKING TEST FOR HIGH HEAT LOAD COMPONENTS IN TAIWAN PHOTON SOURCE

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Abstract

Taiwan Photon Source is the second accelerator constructed by National Synchrotron Radiation Research Center (NSRRC). With 3GeV, 500mA, this facility will generate extremely high synchrotron radiation and most of the power load will be shadowed at front end in order to shape final confining beam size for beam lines users.

The high heat load components are known to be the critical parts to absorb the unwanted energy. In order to practically distribute high density power along each high heat load components, several absorbers are introduced. Namely, primary mask, main mask, photon absorber and slits. The manufacturing process such as UHV chemical cleaning, brazing and helium leaking test will be described in this report.

INTRODUCTION

The Taiwan Photon Source (TPS) is the second accelerator that was built in Taiwan, located at the National Synchrotron Radiation Research Center in Hsinchu, Taiwan. It is a synchrotron light source facility with accelerator energy of 3 GeV, current of 500 mA, and perimeter of 518 M.

This paper introduces the methods of manufacturing, vacuum brazing and helium leaking test methods of the High Heat Load Components (HHLC) in the front end of the accelerator.

Vacuum brazing component can be manufactured mainly through two steps, which are copper plating and hydrogen furnace, which also can be replaced by ultra-high vacuum (UHV) cleaning and brazing furnace [1].

The HHLC in the front end described in this paper mainly contents: primary mask, main mask, photon absorber and slit. These components are mainly manufactured through ultra-high vacuum chemical cleaning and brazing furnace, therefore the cleaning, filler metal fixing and brazing processes and results will be described in this paper.

EXPERIMENTS

Introduction to High Heat Load Components (HHLC)

In the front end of the TPS, the High Heat Load Components installed sequentially from upstream to downstream are: primary mask, main mask, photon absorber and slit, respectively, with the prototype design of the front end shown in Figure 1.

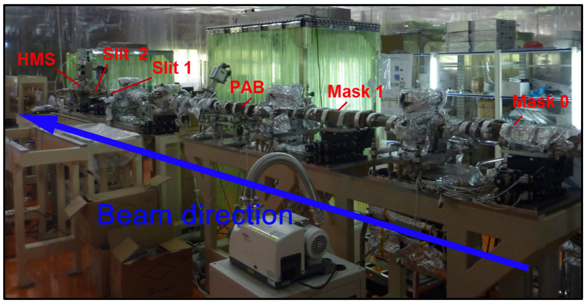

Figure 1: Front-end prototype assembly.

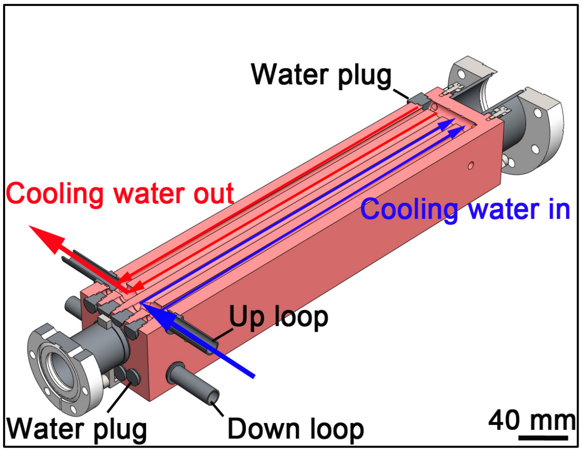

Figure 2: HHLC: Main mask isometric view.

In addition, the HHLC are often designed by taking a modular approach, so the component shapes are similar, but different in length and downstream beam port design. The main mask is the GlidCop® shown in Figure 2 [2].

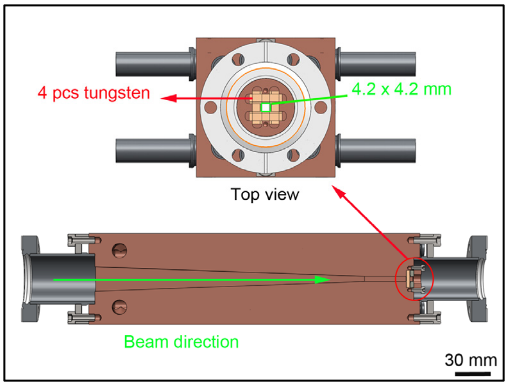

Figure 3: HHLC: Slit.

Slit is an absorber composed by four tungsten blades. It trims the light source, reduces beam scattering and restrict thermal load through high-precision (3 μm/6 mm) tungsten blades [3]. Figure 3 shows a slit.

HHLC Filler Metal Using Method

The HHLC in this article are made through the brazing method. This section describes the filler metal fixing and design specifications [4].

Generally, the filler metal should have the following characteristics:

- filler metal should be able to wet the base metals at the melting temperature so as to join the work pieces together.
- The filler metal needs to have a good liquidity at brazing temperature. In other words, the filler metal relies on capillary action.
- The filler and base metals need to match each other.
- filler metal should not contain too many volatile and toxic substances.
- filler metal shall not corrode the base metal.
- filler metal needs to have some suitable mechanical and physical properties.

RESULTS AND DISCUSSION

HHLC Brazing Product

The HHLC in this article are manufactured mainly through the brazing process, which was developed by the manufacturer from the Hsinchu Science and Industrial Park and the National Synchrotron Radiation Research Center. Table 1 shows the temperature parameters.

Table 1: Vacuum Brazing Furnace-temperature Setting-LUREN

	Ramp rate	Soak temp.	Soak time
SEG 1	0°C/min	5 °C	60 mins
SEG 2	10°C/min	500 °C	90 mins
SEG 3	10°C/min	800 °C	90 mins
SEG 4	7°C/min	960 °C	60 mins
SEG 5	7°C/min	1000 °C	45 mins
SEG 6	0°C/min	45 °C	20 mins
SEG 7	0°C/min	30 °C	30 mins

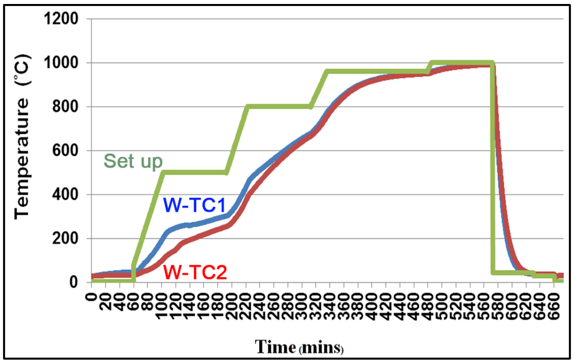

Figure 4: Temperature data: Slit.

Figure 4 shows the heating data of furnaces. It can be learned from the figure that each heating rate is slightly different, so we should maintain the temperature for a certain period of time when the melting point is reached, to facilitate flow and wetting, during brazing. Figure 5 shows a brazed slit.

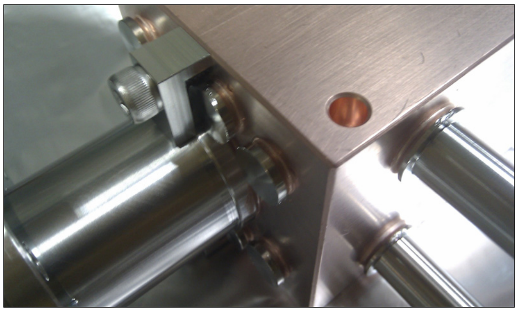

Figure 5: Completed vacuum brazing: Slit.

HHLC Helium Leaking Test Results

After the completion of vacuum brazing, the components will be checked with the helium leaking test method according to the standards that we use. The eligibility criteria must be less than 1 E -9 mbar*l/s. The figure below shows the setting of helium leaking test.

In the figure above, one of the two HHLC ends is sealed with a flange and the other is connected to a leaking detector via a seal valve. The vacuum test is launched by spraying helium to the joints to determine whether there is leakage. Figure 6 shows the results of helium leaking test on all the components.

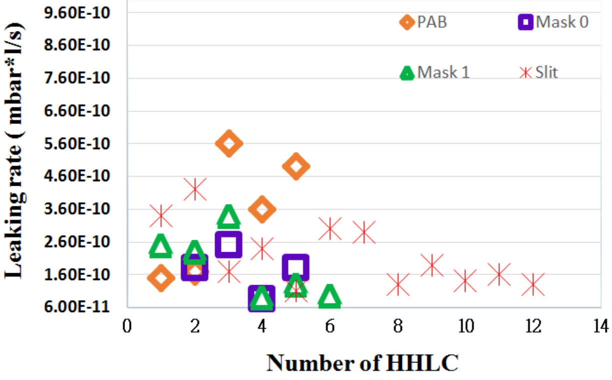

Figure 6: Vacuum leak test results.

CONCLUSION

This study focuses on the vacuum brazing and helium leaking test methods, etc, which are used to check whether we manufactured the TPS High Heat Load Components successfully.

In this study, we manufactured and vacuum brazed 29 High Heat Load Components, including primary mask, main mask, photon absorber and slit. The components are brazed with 50 Au/50 Cu alloy filler metal, with the melting point of 970°C, and are cooled with dry liquid nitrogen.

Most of the brazed components are checked with the helium leaking test. If the leaking rate is below 1 E -9 mbar*l/s, it meets the ultra high vacuum criteria and the manufacturing is successful.

In the final stage of this study, these brazed High Heat Load Components are assembled on the front end of the TPS. After the assembly, the components need to be baked, vacuumed, and finally irradiated by synchrotron radiation light. Our next task is checking whether we can complete above procedures successfully.

REFERENCES

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[4] Roy D. Berry, “Au-Cu-Pd BRAZING ALLOY”, United States Patent Office 3, 136, 633, June 9, 1964.