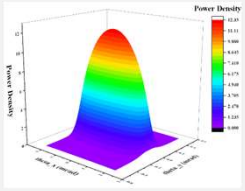
Application of CuCrZr in the Front-end of Shanghai Synchrotron Radiation Facility

Introduction

Glidcop® Al-15, oxygen-free high thermal conductivity（OFHC）copper are the material used for heat absorption in the front-end of synchrotron radiation light source. CuCrZr material has high heat load capacity, high yield strength and tensile strength, good thermal conductivity and low vacuum outgassing rate. The softening temperature is not high enough. Because the brazing process is needed in the processing of the absorber, the brazing process needs more than 500 °C, so the brazing process cannot be used in the processing of the absorber.

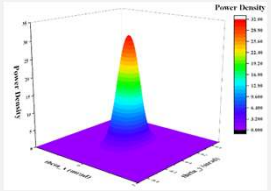
Physical Parameters of Insert Devices

Angle between beamlines is 8 mrad.
The angle between the beamlines and the center line of insert device is 4 mrad.



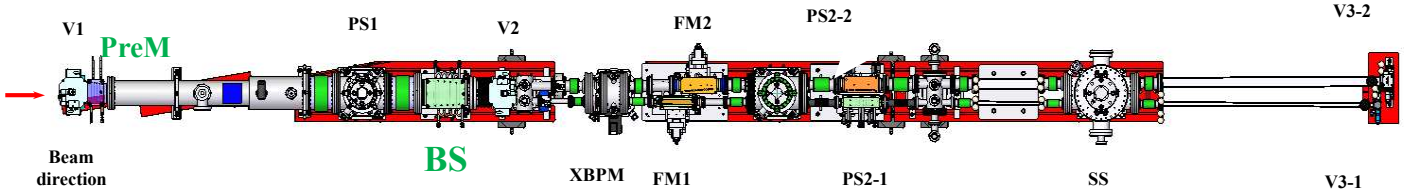
Power density distributions of BL04W

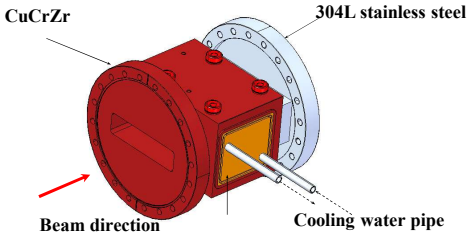
BL 04W	BL 04U
Input angle (mrad²)	
4×1	2×1
Total power(kW)	
9.287	2.62
Peak power density (kW/mard²)	
10.69	30

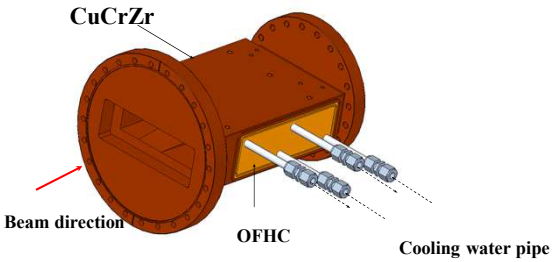


Power density distributions of BL04U

Design of BL04U&04W Front-end

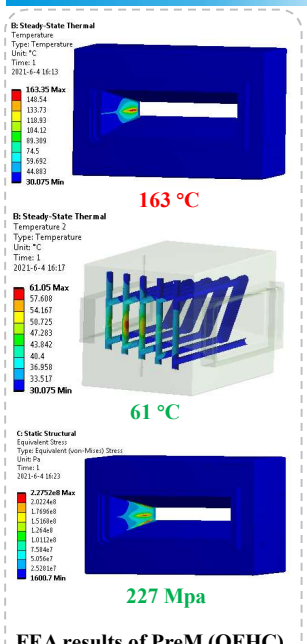




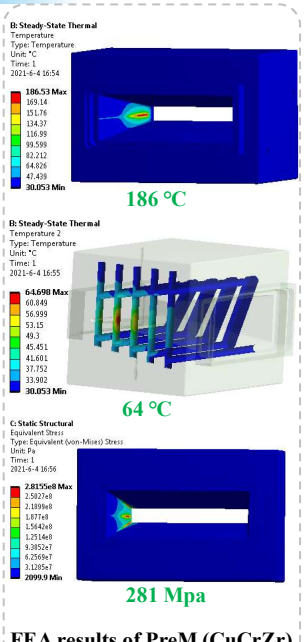


CuCrZr is made as the main body of BS and PreM.
The stainless-steel cooling pipe and the OFHC cover plate are brazed and then using electron beam welding with the CuCrZr part.

Thermal Analysis Results



FEA results of PreM (OFHC)



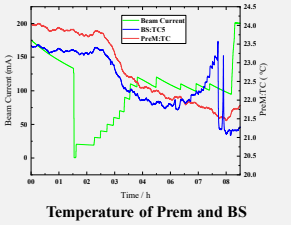
FEA results of PreM (CuCrZr)

Online Test Results

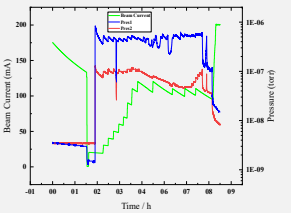
PreM (CuCrZr) and BS (CuCrZr)was tested. Firstly, under the beam current of 20mA to 120mA BL04U undulator gap is gradually closed from 20mm to 6mm, and the BL04W wiggler gap is closed from 100mm to 15mm

The temperature of BS and PreM does not change much, and the temperature rises when the insert device adjusted the gap. From the results of Fig.10 b), the vacuum of front-end changes lfrom-9torr to-6torr, the vacuum is difficult to maintain, but the vacuum gradually decreases

It shows that the light-induced desorption gas release rate of CuCrZr is still large, and it more hours to handle the gas release.



Temperature of Prem and BS



Vacuum of front-end

References:

[1] Chen Ming. Study on Vacuum Properties of CuCrZr based on Synchrotron Radiation High Heat Load [D]. University of Chinese Academy of Sciences,2021.

[2] C,Shueh, C. K ,et al.Investigation of vacuum properties of CuCrZr alloy for high-heat-load absorber[J].Nuclear Instruments & Methods in Physics Research, 2017. doi:10.1016/j.nima.2016.10.025.

[3] Yongjun Li, Limin Jin, Wanqian Zhu, Song Xue, Min Zhang and Shuai Wu. Vacuum joints of CuCrZr alloy for high-heat-load photon absorber[J]. J. Synchrotron Rad. (2022). 29, 363 – 368. doi:10.1107/S160057752101273X

[4] Yongjun Li. Design and Study of High Heat Load Front-end at SSRF [D]. University of Chinese Academy of Sciences,2016.

Contact: Wu Shuai wus@sari.ac.cn
SSRF No.239 Zhangheng Road Pudong New District,Shanghai Advanced Research Institute, Chinese Academy of Sciences, Shanghai