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VACUUM PERFORMANCE TEST OF CuCrZr PHOTON ABSORBERS

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Abstract

To test the pumping performance of NEG coated CuCrZr absorber, we performed a comparative experiment on the two absorbers, one with NGE coating and the other one without coating. First, we run the Monte Carlo simulation by using MolFlow+ code to estimate the pressure inside test chamber at different thermal outgassing rate. And then two absorbers are mounted inside the chamber for the pressure vs. time profiles testing. The experimental set-up and pressure profiles will be presented here.

INTRODUCTION

We have developed two absorbers made of CuCrZr materials. The CuCrZr alloy is the right material for handing high heat load of synchrotron radiation. It has high yield and tensile strength, it has much lower cost than GlidCop, also it can be easily welded with stainless-steel (no brazing process) and also UHV compatibility. The two absorbers were similar in structure and the vacuum sealing flange was integrated with the absorber without any brazed or welded junctions. The 1st absorbers are similar to the ALBA absorber structure [1] and parts of the surface have NGE coating as shown in Fig. 1. The other one refers to the ESRF EBS [2] absorber structure but has no NEG coating on its surface, see Fig. 2. These two absorbers were made up by SAES RIAL and 1st one NEG coated by SAES Getters.

This experiment is to measure the pump-down curves of two absorbers and to see whether the NEG coating on the absorber has pumping effect. In the following sections, we will show the experimental set-up and present the measurement results.

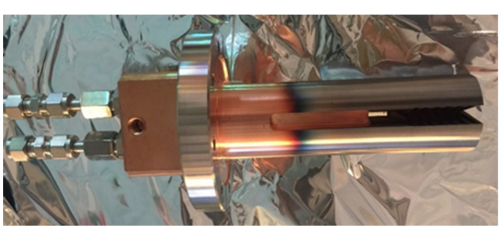

Figure 1: 1st absorber with NEG coating.

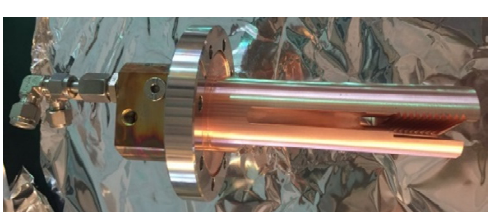

Figure 2: 2nd absorber without NEG coating.

MONTE CARLO SIMULATION

In order to choose the structure of a reasonable experimental system, we performed a simulation calculation using the Monte Carlo simulation code MolFlow+ which was developed at CERN [3].

We designed two types of experimental systems. One was to connect the vacuum chamber directly with a 150 L ion pump. The other was to add a 10mm diameter orifice conductance to the ion pump port. The simulation model is shown in Fig. 3. The simulated pressure results at different thermal outgassing rates are shown in Table 1.

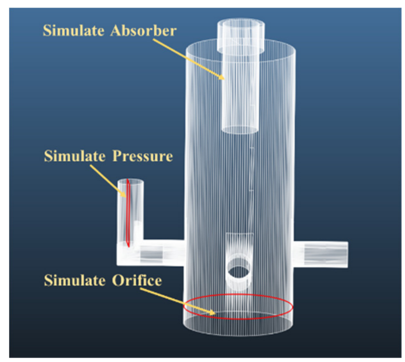

Figure 3: Simulation model.

Based on the simulation results, we set up the experimental chamber with small orifice conductance, so as to the pressure difference between the two absorbers can be more clearly displayed.

EXPERIMENTAL PROCEDURE

NEG coating can be activated after 24 hours baking at temperatures above 180°C. Before NEG coating activation, we need to bake the vacuum chamber to desorb the adhering gas on the inner surface. We developed our own activation curve with reference to the programs of SAES [4] and SOLEIL [5] and combined with the actual conditions of our baking, see Fig. 4.

Bake out operation procedure:

- Assemble the vacuum system including one of two absorbers and flanges.
- Put on the heating equipment (thermocouples and heating tapes) in three parts (absorber and vacuum chamber up and down).
- Start pump-down by primary pump and TMP.
- Switch on Helium Mass Spectrometer Leak Detector to perform leak detection.
- Keeping TMP pumping.

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Table 1: Simulation Parameters and Results

Assumed Vacuum Chamber Thermal Outgassing Rate 2E-10 mbar L/s/cm^2								
Assumed Absorber Pumping Speed on NEG Surface 0.3L/s/cm^2								
Assumed Absorber Thermal Outgassing Rate on Without NEG Surface (mbar L/s/cm^2)								
			5E-10	1E-10	5E-11	1E-11	5E-12	1E-12
Pressure (mbar)	Without Orifice	Without NEG film	1.24E-9	2.80E-10	1.62E-10	6.60E-11	5.36E-11	4.44E-11
		With NEG film	4.77E-10	1.20E-10	7.51E-11	4.16E-11	3.65E-11	3.30E-11
	With Orifice	Without NEG film	2.05E-8	4.63E-9	2.60E-9	9.68E-10	7.68E-10	6.04E-10
		With NEG film	1.45E-9	3.48E-10	2.18E-10	1.07E-10	9.46E-11	8.15E-11

- Bake-out for 24 h, heating stainless-steel vacuum chamber components up to 250°C and absorber parts to 150°C, respectively. In this way, water molecules desorbed by stainless steel under baking cannot stick to the NEG coating. In fact, heating this part to 100°C is enough, but the baking of the stainless-steel vacuum chamber passively heats the absorber part to 150°C under natural cooling conditions only. Heat up vacuum gauges and sputter-ion pump also, compatibly with their temperature limitations.
- At the end of the 24 h bake-out, start NEG activation by heating up NEG-coated parts to 230°C. Keep activating at the temperature for 24 h. When the temperature of the NEG-coated parts increases, cooling down stainless-steel vacuum chamber ones to 100°C and maintaining for about 5h.
- When the vacuum chamber temperature down to 150°C, flash the sputter-ion pumps and keep it switched on. When the vacuum chamber down to 100°C, degas the vacuum gauges and let it on to the end.
- When vacuum chamber temperature is cooled down to 100°C for 1 hour, close the valve to isolate the vacuum system and the molecular pump and start to record the pressure.
- Cool down the system to room temperature.
- Continue to record the pressure 12 to 13 hours for the pressure profiles.

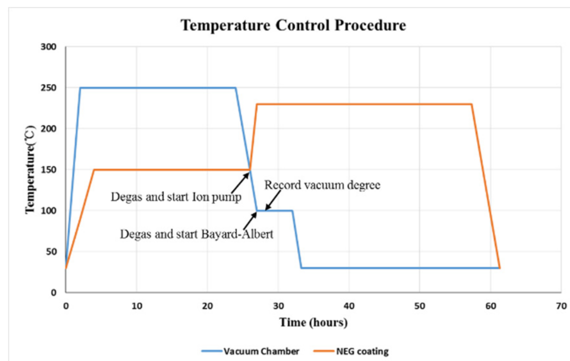

Figure 4: Temperature Control Procedure.

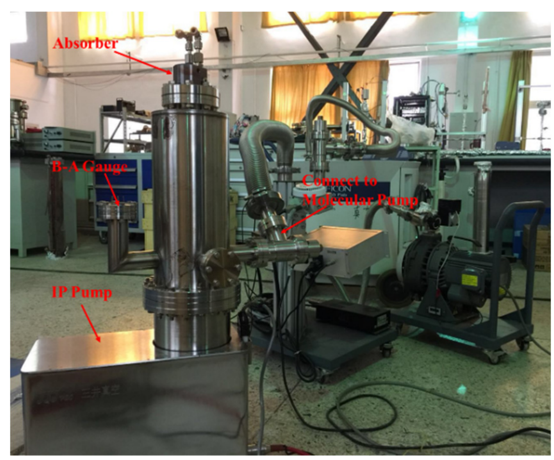

Figure 5: Experimental Set-up.

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PRESSURE CURVES AND CONCLUSION

We set up a test system (Fig. 5) and conducted the experiments on two absorbers (one with NGE coating and the other one without coating). The two test conditions were kept as same as possible. Comparing the pressure vs. time curves of the two experiments, the NEG-coated absorber has a lower pressure (Fig. 6). This shows that the NEG-coated one has some pumping effect, and more coated surface area may help pumping more. Further investigation will be needed.

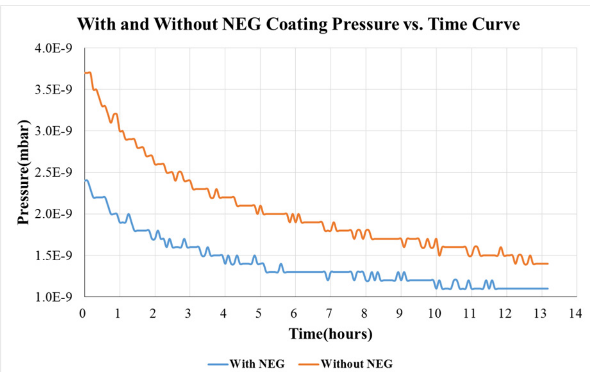

Figure 6: Pressure vs. Time Curve.

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