BL-13B/Beamline commissioning

Development of a Low-Cost, High-Performance Non-Evaporable Getter (NEG) Pump

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A low-cost, high-performance non-evaporable getter (NEG) pump was constructed using commercial NEG pills comprising 70 wt% Zr, 24.6 wt% V, and 5.4 wt% Fe, a conflat flange with an outer diameter of 70 mm (CF70), and a tantalum heater. After activation at 400 °C for 30 min, the pumping speeds of the CF70 NEG pump measured with the orifice method were 47–40, 8–6, 24–17, and 19–15 L/s for H_2, N_2, CO, and CO_2 gasses, respectively [1].

1 Introduction

Non-evaporable getter (NEG) pumps are ideal for maintaining an ultra-high vacuum (UHV) of $\leq 10^{-8}$ Pa because they have a high pumping speed in UHV, are oil free, compact, lightweight, evaporation free, sputtering free, sublimation free, vibration free, economical, and energy saving. One of the most popular NEG materials is an alloy comprising 70 wt% Zr, 24.6 wt% V, and 5.4 wt% Fe developed and commercialized by SAES Getters under the trademark of St 707 [2]. St 707 NEG can be fully activated by heating to 400 °C for 45 min or to 350 °C for about 24 h [3]. In the present paper, we describe a NEG pump constructed of commercial NEG pills, a conflat flange with an outer diameter of 70 mm (CF70), and a tantalum heater. The pumping speeds of the CF70 NEG pump measured with the orifice method [4] were 47–40, 8–6, 24–17, and 19–15 L/s for H_2, N_2, CO, and CO_2 gasses, respectively.

2 Construction and Evaluation of a NEG pump

We have constructed a NEG pump using 84 NEG pills comprising Zr-V-Fe alloy, Zr 70 wt%, V 24.6 wt%, and Fe 5.4 wt% (ϕ10 mm × 3 mm; Alvatec Alkali Vacuum Technologies GmbH, APG-10-3-001-01, same composition as St 707), two alumina tubes (ϕ1.2 mm × ϕ0.8 mm × 100 mm), a tantalum wire (ϕ0.2 mm × 230 mm), and a CF70 with electrical power feedthroughs as shown in Fig. 1. Titanium plates, rods, washers, screws, and spacers are used to suppress outgassing and to improve mechanical strength. The NEG pump can be activated at 400 °C by heating the tantalum wire with a current of 2.8 A using a commercial electric power supply.

Pumping speeds of the CF70 NEG pump were measured for H_2, N_2, CO, and CO_2 gasses with the orifice method [4] using the apparatus shown in Fig. 2. The pumping speed (S) of the vacuum pump is given by the following equation in the molecular flow region [4].

$$S = C\left(\frac{P_a - P_{0a}}{P_b - P_{0b}} - 1\right),$$

where P_a and P_b represent the pressure of the downstream and upstream chambers measured by B-A gauges, respectively, and P_{0a} (P_{0b}) is the base pressure of the downstream (upstream) chamber. Since the orifice has a diameter of 10 mm and a thickness of 0.5 mm, the conductances of the orifice are 33.27, 8.89, 8.89, and 7.09 L/s for H_2, N_2, CO, and CO_2 gasses, respectively, at 26 °C. Measured pumping speeds of the CF70 NEG pump were 47–40, 8–6, 24–17, and 19–15 L/s for H_2, N_2, CO, and CO_2 gasses, respectively.

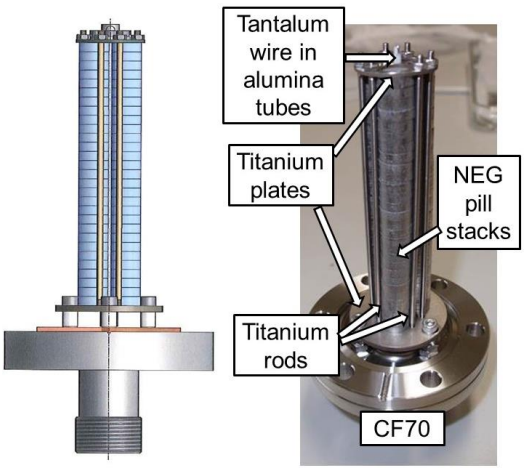

Fig. 1 Schematic and photograph of the CF70 NEG pump using 84 NEG pills [1].

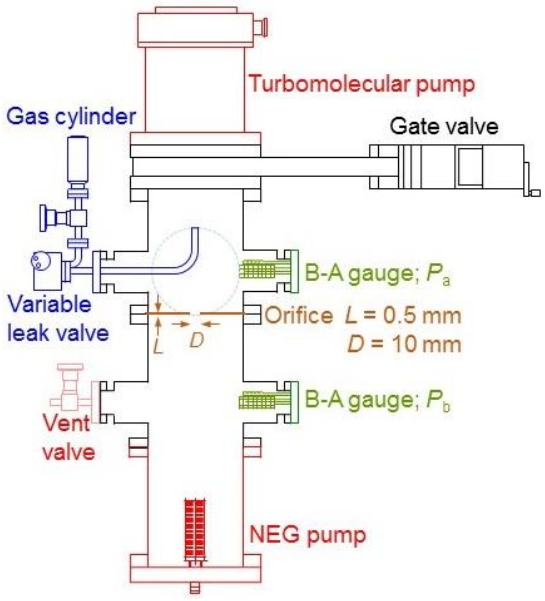

Fig. 2 Apparatus used for measuring the pumping speeds of the NEG pump [1].

3 Conclusions

We have constructed an NEG pump using NEG pills comprising 70 wt% Zr, 24.6 wt% V, and 5.4 wt% Fe, titanium parts, alumina tubes, a tantalum wire, and a CF70 with electrical power feedthroughs. The NEG pump can be activated at 400 °C by heating the tantalum wire with a commercial electric power supply. The pumping speeds of the CF70 NEG pump measured with the orifice method were 47–40, 8–6, 24–17, and 19–15 L/s for H_2, N_2, CO, and CO_2 gasses, respectively. The low-cost, high-performance NEG pump is a favourable alternative to sputtering ion pumps in VSX beamlines. The NEG pump can also be used for accelerators, front ends, end stations, and differential pumping systems.

Acknowledgements

This study was supported by a Grant-in-Aid for scientific research (KAKENHI: No. 26390070). The authors are grateful to Prof. K. K. Okudaira (Chiba Univ.), Prof. H. Kato (Hirosaki Univ.), Prof. M. Tanaka (Yokohama National Univ.), Prof. S. Ohno (Yokohama National Univ.), Mr. A. Toyoshima (KEK-PF), Mr. H. Tanaka (KEK-PF), Mr. H. Nishiguchi (Baroque International Inc.), and Ms. E. Kazama (Baroque International Inc.) for their invaluable advice and support.

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