Gas circulation and purification system for RIBF-PALIS experiment[†]

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A gas circulation and purification system was developed for the parasitic low-energy RI-beam production system (PALIS).[1,2] The development was motivated by the following three requirements; 1) to avoid pollution by radioactive Ar gas (^{41}Ar, $T_{1/2}$=109.61(4)min) diffusing into the air, which is created by the reaction of ^{40}Ar and an intense neutron flux; 2) to reduce consumption of the buffer gas, since the exhausted buffer gas ejected from the gas cell was thus far disposed of via a differential pumping system; and 3) to enhance the gas purity to avoid a loss in the low-energy RI-beam extraction efficiency.

An overview of the gas cell, differential pumping system, and the gas circulation and purification system is shown in Fig. 1. The main part of the gas circulation system is located 5 m away from the BigRIPS F2 room. The interfaces between the PALIS gas cell and circulation system consist of several long gas tubes and compressed air tubes for valve control. During on-line beam experiments, the radiation level in the F2 room increases by several hundred mSv, whereby the main contribution to the radiation is the high-intensity neutron flux. Therefore, it is not possible to access the F2 room during experiments, and all devices should be controlled remotely. A high-flow-rate gas cell filled with 1 atm of buffer gas (argon or helium) is used for the deceleration and thermalization of high-energy RI-beams in PALIS experiments. The exhausted buffer gas is efficiently collected using a compact dry pump and returned to the gas cell. The buffer gas is efficiently purified using two gas purifiers as well as through collision cleaning, which eliminates impurities including gas.

We have achieved a gas recovery efficiency of 97% for Ar, when the pressure of the gas cell was set at 10^5 Pa. This value falls within the permissible range considering the natural abundance of ^{41}Ar in air. In addition, the consumption of the expensive, high-purity buffer gas was drastically reduced. The replacement rate of Ar gas to a new bottle (47 L, 15 MPa) amounts to just one bottle per week, even if a gas flow rate of 15 L/min is spent continuously to maintain a pressure of 1 atm in the gas cell. Moreover, the achieved gas purity was 99.9999999% (grade 9.0; impurity level: 1 part per billion (ppb)), which was evaluated from the moisture content in the gas using a dew-point transmitter.

This system can be extended to any application based on a gas cell and is feasible for any type of gas. Particularly, in the semiconductor production process, highly pure argon gas is indispensable for use as atomospheric gas, but the gas is usually used once and then disposed of. The reduction of cost of highly pure argon gas is expected on implementing the gas circulation and purification system.[3]

Detail information on this work can be founded in a published article.[4]

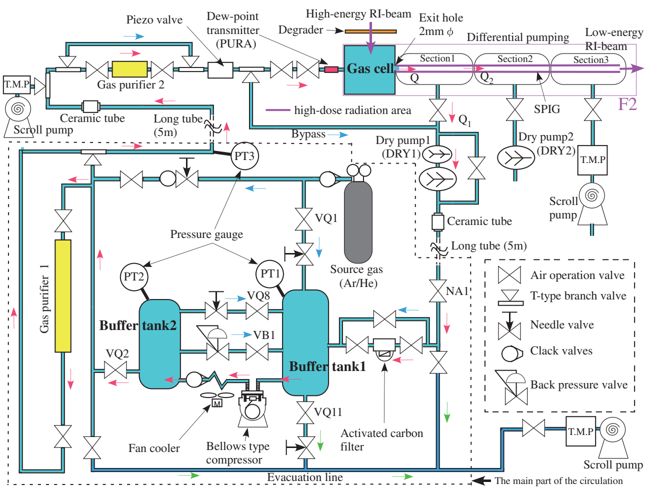

Fig. 1. Overview of the gas cell and the gas circulation and purification system. The red arrows indicate the regular direction of circulation, and the green arrows indicate the direction of the evacuation line. The blue arrows indicate the direction of gas flow under some special conditions.

References

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