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# Development of portable Ball SAW Moisture Analyzer by using USB Pulsar

## USB パルサーを用いたポータブルボール SAW 水分計の開発

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### 1. Introduction

For the material of lithium ion battery or organic electro luminescence display easily reacts with water molecules, it is important to control the trace moisture in the dry chamber. However, in the load lock chamber to load a moisture-protected material into the dry chamber, mixing of the atmospheric air is a problem. It is thus required to monitor the trace moisture in the load lock chamber at the time resolution of the order of seconds. But, at present, there is a problem with response time of a commercially trace moisture analyzer.

We developed an ultra-trace moisture analyzer by using the ball surface acoustic wave (SAW) sensor coated with a sol-gel silica sensitive film [1-4]. In this study, we develop a portable ball SAW moisture analyzer by using a USB pulsar which can measure frost point of -70 ℃, at a high speed and a low cost. Then, we measure the moisture change in a dry box simulating the load lock chamber, and verify on-site adaptability.

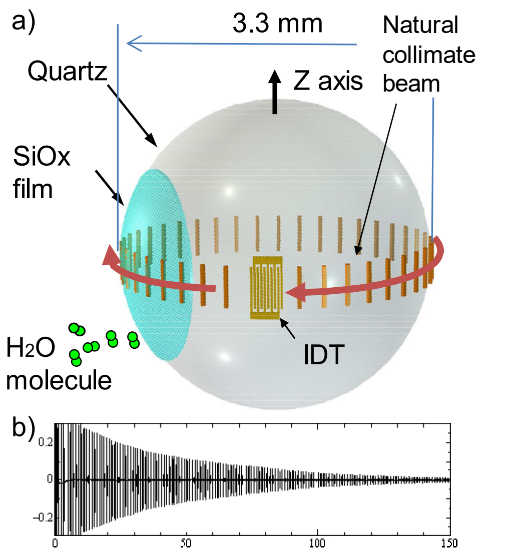


Fig. 1 (a) Schematic diagram of ball SAW sensor. (b) Waveform of roundtrip of SAW.

### 2. Principle

A schematic diagram of a ball SAW sensor with a silica sensitive film is shown in **Fig.1**. When SAW is excited with a specific width on a sphere, it makes multiple roundtrips as shown in **Fig.1 (b)**. For this phenomenon, it is known that attenuation of SAW can be measured at high sensitivity, and that the viscoelastic effect of the sensitive film is sensitive to frost point of -70 ℃.

### 3. Experimental setup

To simulate a load lock chamber, a 20 cm square acrylic box was equipped with an inlet and exhaust port for dry nitrogen flow, and a cover which can be opened and closed at a high speed [**Fig. 2(a)**]. We installed a matching network and a ball SAW sensor of 150 MHz and a thermistor in the dry box [**Fig.2 (b)**].

**Fig. 2(c)** shows a view of the USB pulsar, and **Fig. 2(d)** shows a block diagram. The USB pulsar can excite, receive and detect ball SAW with the USB bus power. It boosts 5 V of USB power supply to 200 V and generates

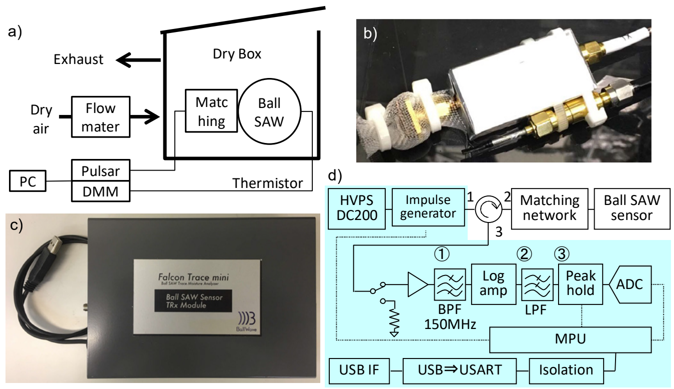


Fig. 2 (a) Experiment setup for simulating the load lock chamber. (b) Ball SAW trace moisture sensor unit. (c) Appearance of USB Pulsar. (d) Block diagram of USB pulsar.

an impulse for SAW excitation at a 0.5 ms interval [5].

The signal returned from the ball SAW sensor through the circulator is acquired by the analog-to-digital converter after passing through a band pass filter, a log amplifier and a peak hold circuit. In this experiment, the peak values at two turns were averaged 1000 times to measure the attenuation. As a result, the measurement interval was 1 second.

## 3. System development

The ball SAW sensor was calibrated using a temperature controlled cell by Peltier element. **Fig. 3(a)** shows a response of attenuation change when frost points were changed using a bubbler at flow rate of 0.1 L/min. A response of attenuation change was observed at the frost point of -70 to -20 ℃. As the frost point increased, the attenuation increased.

**Fig. 3(b)** is the calibration curve to measure the frost point of -70 to -20 ℃ from the attenuation, interpolated by the spline method. It showed a good linearity in the frost point range of -60 to -30 ℃.

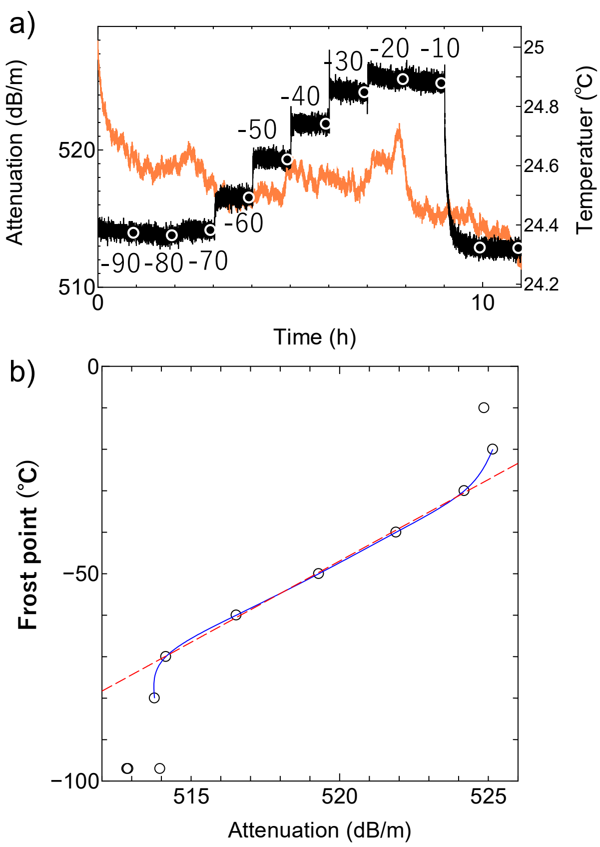


Fig. 3 (a) Frost point dependence of attenuation. (b) Calibration curve using spline interpolation.

## 4. Result

The change in the frost point is shown in **Fig. 4(a)**, when dry nitrogen was flowed to the dry box at 6 L/min, and the cover was opened for 0.3 seconds and closed. Reproducibility of four experiments was high. We confirmed wetting by the atmospheric air and saturation in 10 seconds. We also observed that the dry down takes 5 minutes.

Next, a flow rate dependence of the frost point behavior is shown in **Fig. 4(b)**. As the flow rate decreased, the baseline increased. The reason is thought that there is a leak in the dry box.

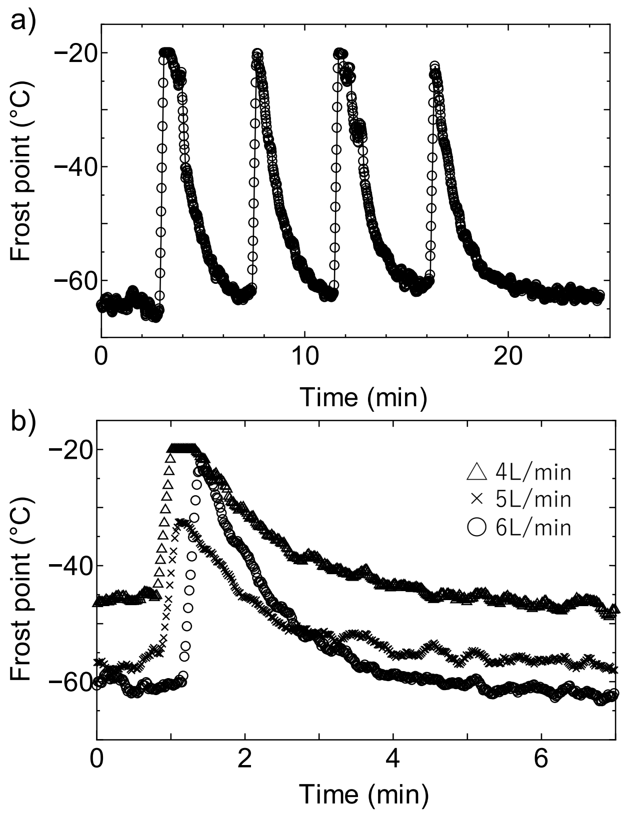


Fig. 4 (a) Response of frost point due to opening and closing of the cover at flow rate of 6L / min. (b) Flow rate dependence of frost point behavior

## 5. Conclusion

We developed a portable trace moisture analyzer by using a fast response ball SAW sensor and a USB pulsar. We demonstrated the on-site adaptability where the moisture control of the load lock camber is necessary.

**References**

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