1P2-1

Viscous-characteristics of glycerin water solutions with Q-factors of SC-cut QCM

SC カット QCM の Q 値を用いたグリセリン水溶液の粘性特性

Shin-ya WATANABE, Yasuaki WATANABE, Yunhao MA and Takayuki SATO (Grad. School of S. and E., Tokyo Metro. Univ.)
渡邉慎也，渡部泰明，馬　昀灝，佐藤隆幸　（首都大　理工）

1. Introduction

SC-cuts demonstrate superior performance as crystal resonators. For example, phase noise characteristics and long-term stability are achieved when SC-cuts are used as oscillators[1-4]. A trial for using SC-cut quartz crystal in QCMs (Quartz Crystal Microbalances) is the foundation of this paper[4]. This paper first outlines the SC-cut resonator and then expresses a method for measuring liquid viscosity. No precedent exists for using an SC-cut sensor for viscosimetry, so an experiment using Q was attempted. The relationship between the used viscosity and that of a glycerin water solution as a traditional solvent was examined.

It was shown that only a difference of 20 to 15 degrees Celsius causes SC-cuts to escape from neighborhood spurious influence.

2. SC-cut Crystal Resonators

First, B mode was applied because there were many shifts in the temperature with the SC-cut resonator.

Figure 1 shows the shape of the double rotation in SC-cuts, and each azimuth represents (θ, φ) = (21.93, 33.93)[5].

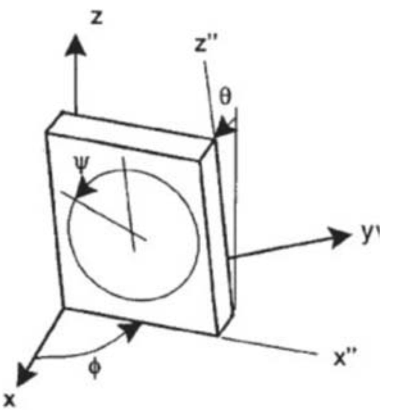

Fig. 1 Azimuths of SC-cut resonator.

Contact: y.watanabe@ieee.org

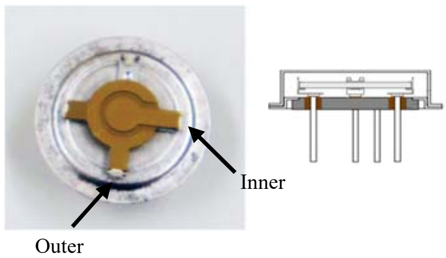

Fig. 2. SC-cut QCM sensor. (a) Photograph of exterior. (b) Structural drawing.

Fig. 3. Encased SC-cut QCM sensor.

3. SC-cut Sensor Devices

Figure 2 shows a profile of the resonator and divides it into C inner, C outer, B inner, and B outer, focusing only upon B outer. B outer is used because the frequency sensitivity for the temperature is high[6]. This sensor was placed in a case as show in Fig. 3 and was monitored.

4. Experiment Briefs

First, the glycerin density is set to 10 and 30 wt%, and the temperature is assumed to be between 20 and 15 degrees Celsius as previously stated. The experiment was carried out using a network analyzer, and an anti-shooting method by S-parameter S11 was applied as shown in Fig. 4. The output power of the network analyzer was -5 dBm.

In addition, the relationship between the used viscosity and that of the glycerin water solution was mainly handled using Q (sharp grade), and the density appeared constant.

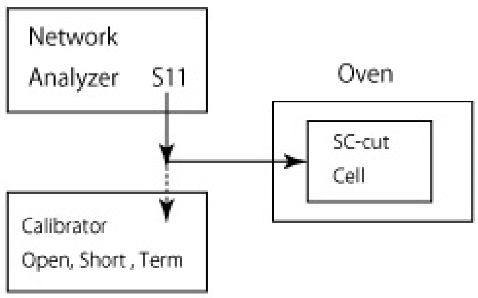

Fig. 4. SC-cut QCM sensor cell with network analyzer unit.

4. Experiment Results

First, a glycerin water solution is set to 0, 10, and 30 wt% as shown in Fig. 5 for 20 degrees Celsius, and the results determined by Q by actual survey using QCM are shown. Moreover, the simulation results for glycerin (shown by the gray circle) were used for Q. Q_0, Q_{10}, and Q_{30} by the non-linear least squares methods.

This coefficient was next applied to the glycerin water solution at 15 degrees Celsius. As a result, spurious influence was judged to be present, but was judged with 30% accuracy because a valid result could not be obtained; a high degree of spurious influence makes obtaining accurate data difficult. A method is needed to classify spurious influence to obtain accurate data.

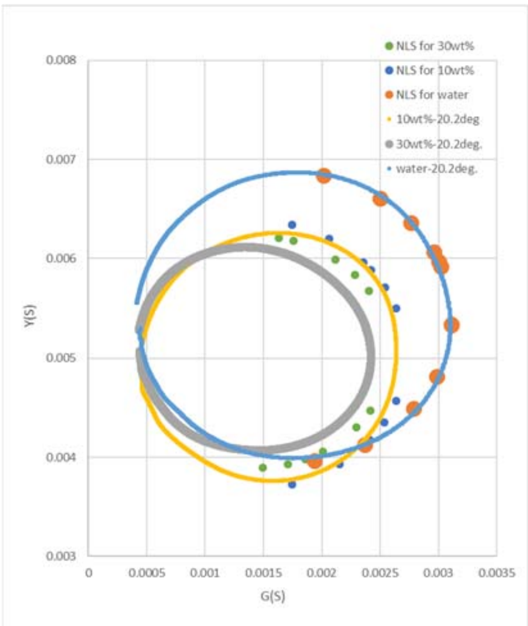

Fig. 5. SC-cut QCM sensor cells with glycerin water solutions for 20 degrees Celsius.

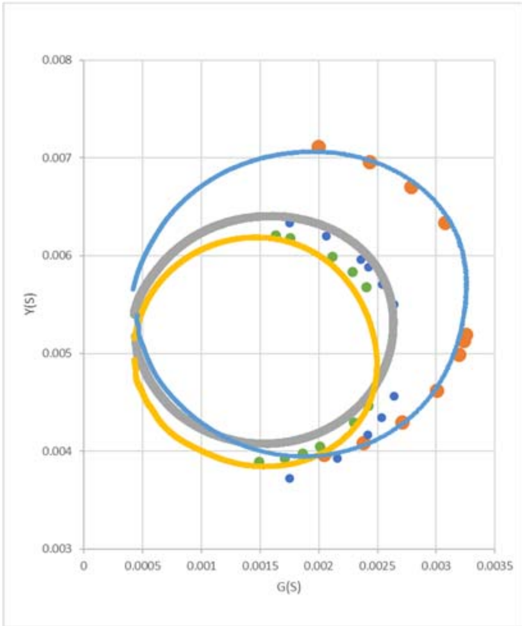

Fig. 6. SC-cut QCM sensor cells with glycerin water solutions for 15 degrees Celsius.

4. Conclusion

When the glycerin water solution was kept at 20 degrees Celsius, the viscosity of each density was calculated using Q of the SC-cut.

Results at 20 degrees Celsius agreed well for 10 and 30 wt%. Spurious resonance was an influence at 15 degrees, and the resulting data were incongruent with the data obtained at 20 degrees. Future work will focus on getting results to match at 20 and 15 degrees.

Acknowledgments

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