APPLICATION OF QCM SENSOR DEVICE IN SOME AQUEOUS SOLUTIONS

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Abstract: The quartz crystal microbalance (QCM) is well-established method for the measurement of small changes in mass, based on the relationship between changes in mass of material attached to the crystal and the oscillation frequency of the crystal. This device were set-up to present the practical approach to the development of instrument control software in the LabVIEW environment using the GPIB interface in order to investigate the influence of density and viscosity of some aqueous solution to the frequency response of the QCM and the results were correlated with the theory.

Keywords: Quartz crystal microbalance, liquid sensor, LabVIEW

INTRODUCTION

Sensor system design

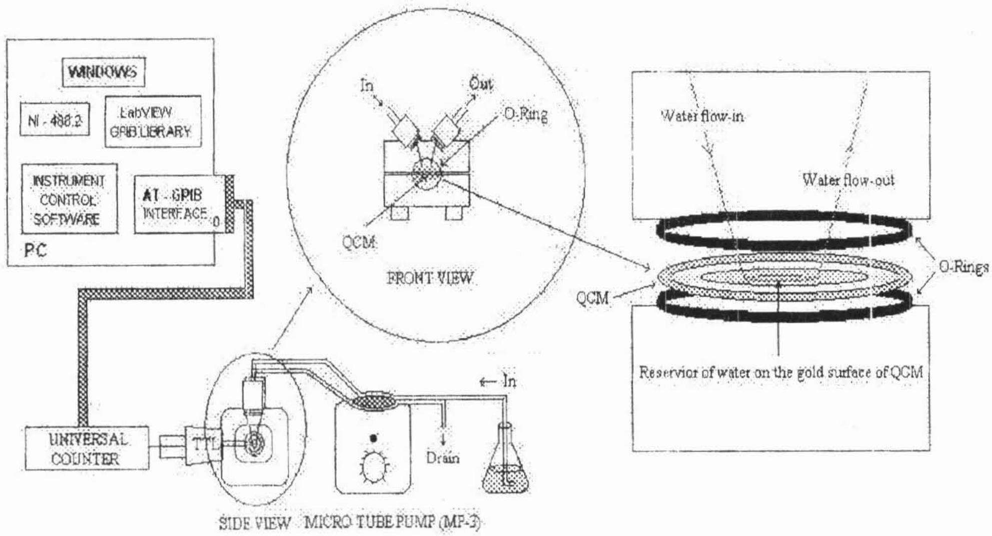

Figure 1: Experimental set-up

MATERIALS AND METHODS

Materials

Uncoated quartz crystal (9 MHz) and (10 MHz)
Piezoelectric Liquid Flow Cell (2 set)
Piezoelectric Crystal Lever Oscillator (2 set)
DC Voltage Current Standard, Type 2553
2 O-rings (2 set)
Micro Tubing pumps (Model MP-3, Eyela, Tokyo Rika)
Universal Counter (Model 53131A, Agilent Intuilink)

Spiral tube
GPIB cable
LabVIEW software
Ubblohde viscometer
Pycnometer

Apparatus Set-up

We have used AT-cut quartz crystal with resonance frequencies of 9 MHz and 10 MHz for our investigations. Only one side ('one side cell') were contact with liquid in order to eliminates the influences of conductivity and dielectric constant and to reduce the liquid damping.

Figure 1 shows the scheme of the experimental setup. The liquid flow cell were made of Pyrex and Lever Oscillator (TTL) used were made from ICM (Oklahama City) for 10 MHz crystal. For 9 MHz crystal, the circuit and liquid flow cell were made in the laboratory.

An AT-cut crystal electrodes was inserted in oscillator supplied with 5 V for 9 MHz crystal and 9 V for 10 MHz crystal by a variable supply (DC Voltage Current Standard, Type 2553)

The surface of the QCM was clamped between two O-rings with liquid flow cell. Only one side of the wafer and one electrodes, which serves both as a part of the QCM oscillator circuit and as the working electrode in contact with solution.

The frequency change was monitored by a universal counter (Model 5313A, Agilent Intuilink) which were control by a microcomputer with a GPIB interface.

Test solutions were applied in a flow cell in which the quartz crystal was installed, propelled by a micro tubing pump, (MP-3, Eyela, Tokyo Rika) using the spiral tube. The flow-rate was 1.3-1.6 ml min^{-1}, no dependence of the flow-rate on the frequency change was found.

Procedure

The reference state was oscillation in water was first applied. After stabilization of the frequency with water, test solutions were applied stepwise from low to high concentrations. At the end of each experimental run, water was applied to check the reversibility of the frequency. The frequency of the crystal was measured every 5 seconds for all concentration of solutions.

For such measurement, the crystal must be fixed with a liquid-tight seal to avoid leakage of liquid to the electrode on the other side. This sometimes caused the crystal to break under the stress of the fixture. The specific viscosities of various solutions were measured with a Ubblohde viscometer and pycnometer, respectively.

RESULTS AND CONCLUSIONS

We have carried out our QCM measurements with some aqueous solution with our one-side cell using the development device and program. An uncoated quartz crystal was used for monitoring changes of viscosity and density of the liquid simultaneously. Figure 2 and 3 shows the frequency shift due to the changes of the properties of sucrose and salt concentrations in water.

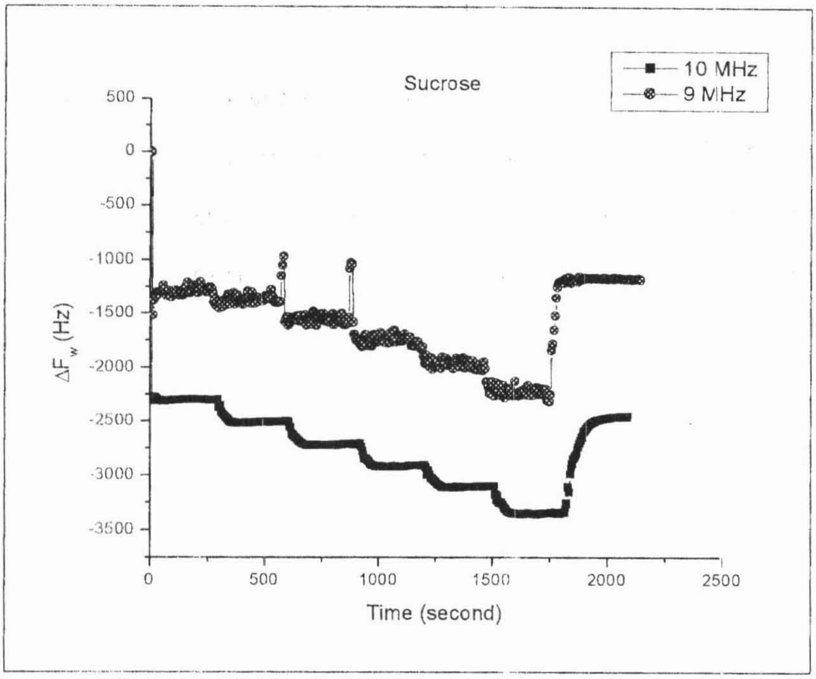

Figure 2: Sensor responses for 9 MHz and 10 MHz crystal with different concentrations of sucrose (5, 10, 15, 20 and 25 wt%)

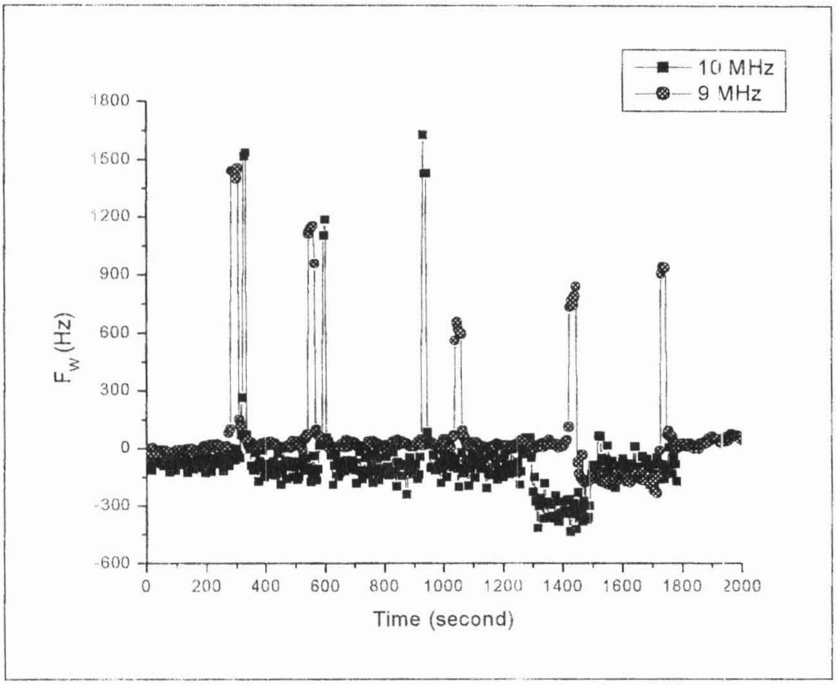

Figure 3: Sensor responses for 9 MHz and 10 MHz crystal with different molarity of NaCl (0.001, 0.01, 0.1, 1.0 M)

In conclusion, the construction program and modification of the device meets the immediate needs of controlling the frequency response of the QCM due to investigate the saltiness and glucose level in water and has been confirm experimentally.

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