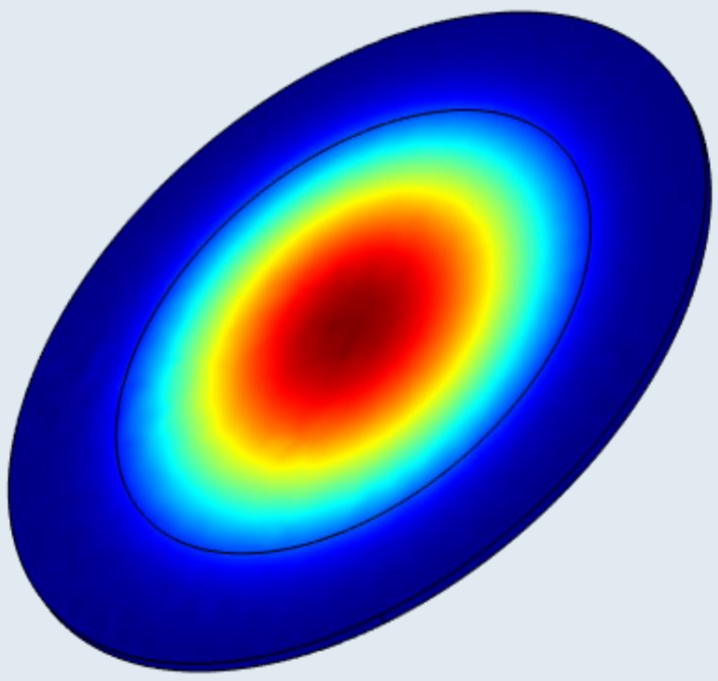

Research on piezoelectric acoustic humidity sensor based on finite element

When the film is formed on the electrode surface of the quartz crystal resonator, its viscoelastic properties cause that the center frequency of the sensor does not always decrease linearly with the increase of the film radius.

Qian Xu[1],Shicheng Zhao[1],Qiaozhen Zhang[1*],Xiangyong Zhao[2*]

1. School of Information and Mechanical and Electrical Engineering, Shanghai Normal University, Shanghai 200234, China

2. College of Mathematics and Physics, Shanghai Normal University, Shanghai 200234, China

*Correspondence:zhangqz@shnu.edu.cn and xyzhao@shnu.edu.cn

Abstract

Piezoelectric materials produce voltage when subjected to mechanical stress, which makes piezoelectric materials have a wide range of applications in the field of acoustic sensors. Humidity measurement and control are widely used in various fields such as grain storage, weather forecasting and processing, and national defense construction. In today's society, the demand for a variety of low-cost and excellent performance humidity sensors is increasing. The quartz crystal microbalance (QCM) has the characteristics of high sensitivity, no physical contact, small size, easy integration, etc., by covering the surface of the quartz crystal microbalance with a material that can respond to water molecules, it can monitor the humidity in the environment. This material is able to absorb and desorption water, which changes the quality of the quartz crystal, which in turn affects its resonance frequency.

Methodology

In this study, an AT-cut quartz piezoelectric crystal resonator with a frequency of 15MHz was selected as the substrate, and a layer of SBA-15 water sensitive film made of zinc oxide was coated on the vibrating surface of the quartz crystal to make a QCM humidity sensor which can be used for environmental humidity detection. When water vapor is absorbed on the QCM surface, the quality of the QCM sensitive film increases, and its natural frequency also changes. First, we observe the performance of no-load QCM without hygrosensitive film plating and the effect of SBA-15 plating on the sensor performance, and then study the effect of film radius on the performance parameters.

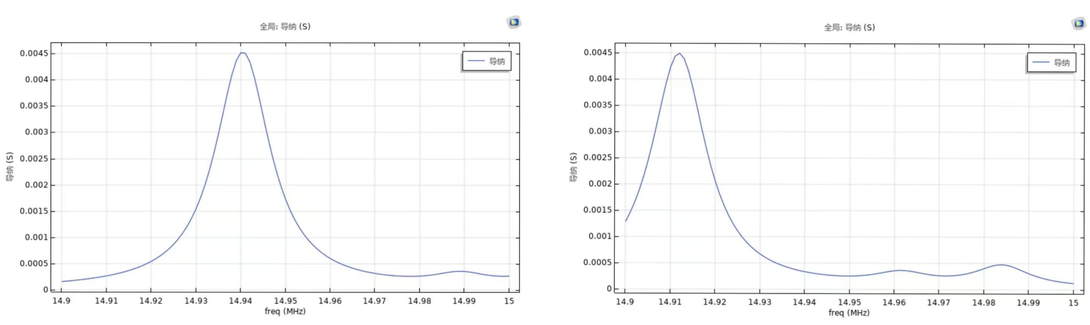

Figure 1. Admittance of no-load QCM (left) and loaded SBA-15 film QCM (right)

Results

The SBA-15 film is adsorbed on the electrode surface of the quartz crystal resonator. With the increase of the film radius, the viscoelasticity of the material makes the center frequency of the sensor not linearly decrease. The measurement sensitivity distribution and electrical impedance characteristic curve of the sensor are very sensitive to the distribution of the film.

Film radius (mm)	*Center frequency (Mhz)*	*Frequency shift*	*Maximum conductance*
0.0	14.947470	0	0.00452
2.0	14.924746	22724	0.00657
2.4	14.917745	29725	0.0024
2.8	14.912745	34725	0.00449

Table 1. The base resonant center frequency of QCM with the film radius

参考文献

[1] Zhang Yan, Wang Shengzhao, Zhu Ye, et al. 3D Finite element Modeling and Simulation of QCM Humidity Sensor modified by SBA-15 film [J]. Electronic Technology and Software Engineering,2017,(10):127-128.

上海师范大学 Shanghai Normal University