

NAME: Arshi Salamat

SUPERVISOR: Prof. Tarikul Islam

Deptt. of Electrical Engg.

THESIS TITLE: Development of Sensing Devices for Analyzing the Quality of Beverages

FINDINGS

Detection of ionic impurities is focussed to provide productive and auspicious information about the beverages adulterated by different substances to make a big profit by industries/vendors. During our research a thorough study has been done to elucidate the importance of adulteration detection (especially milk) and accentuate the importance and necessity of the improved detecting methods. The focus of this research is to fabricate different sensors for monitoring, measurement, and detect different types of adulterations in milk and water. Efforts are made to design and fabricate simple sensors structures that can be fabricated with inexpensive materials but can be useful for the desired purposes.

Firstly, a simple measurement system is proposed where the constant phase element is fabricated to detect the milk adulterated with water, whey and urea. The CPI sensor shows constant phase behaviour over a certain range of frequencies which helps in designing a signal conditioning circuit independent of frequency to obtain better results. But the phase angle changes due to change in ionic impurities. The CPI sensors were fabricated using two different methods to provide porous insulating sensing layer. The two methods were the sol gel and the anodization technique. The material used to form the insulating sensing layer was aluminium oxide which is robust, chemically inert and mechanically stable. The purpose of insulation layer helps in improving and optimizing the sensitivity of the sensor.

Further, an effort has been made to employ the double-sided copper clad PCB as a fringing field capacitive sensor to monitor the electrical parameters like capacitance, conductance etc. due to addition of water in milk. It can be used to fabricate contact or non-contact type capacitive sensors to investigate the dielectric properties of sensing phenomena. The sensors were fabricated using two types of insulating layers (PDMS and plastic lamination) over the double sided copper clad PCB and the third one was fabricated without any insulation. The fabricated sensor was tested in milk adulterated with water. Different

electrical parameters such as impedance, phase angle, capacitance, conductance and susceptance change etc. were observed for different samples. The response curves so obtained helped to detect varying amount of water of adulteration in milk.

A conductive structure called cross-conductance was designed and successfully developed which is an extension of the well-known Thompson and Lampard theorem. Important features of this technique are simple arrangement, easy fabrication of the sensor and effective adulteration monitoring with accurate measurement of the conductivity of the milk samples. The sensor was tested for water, whey and urea added milk samples. A simple interfacing was used to obtain different amount of adulterated substances in milk in terms of output voltage. The accuracy of the conductance measuring system depends only on single length measurement, hence requires no calibration and the sample required for testing was also very small.

Finally, a humidity sensor was fabricated using anodized porous alumina capacitive sensor to measure the relative humidity. Humidity is a significant parameter that may affect measurement parameters of the sensors for quality analysis of beverages and hence its measurement and vigilance is very useful in maintaining the good condition of equipment, sensors and samples. The work describes the development of the capacitive humidity sensor with an anodic film obtained by anodization technique. Here, the sensor utilized both the sides of the aluminium strip to enhance the sensitivity without changing the geometrical parameters or pore morphology of the sensing film. Two types of sensors were fabricated with different pore morphology and their transient and dynamic characteristics were investigated and compared.