Biosensor for Quality Control

Fredrik Brosjö[1] & Andreas Norrgren[2]

[1] Department of Design Sciences
Division of Packaging Logistics

[2] Department of Measurement Technology and
Industrial Electrical Engineering
Division of Electrical Measurements

Faculty of Engineering - Lund University

LUND UNIVERSITY

A large factor in the environmental impact is due to that fine meat is unnecessarily thrown away, mostly because consumers are uncertain if the meat is edible close to the expiry date. A biosensor integrated in the meat package could be a complement to the present expiry date, which could reduce the food waste. The sensor can monitor the bacterial growth and alert the consumer, when the number of bacteria has reached a critical level. Even when the expiry date has passed, the sensor could indicate that the bacterial level is below the critical and the meat can be consumed. A master's thesis has been done at Lund University, where such a sensor has been developed.

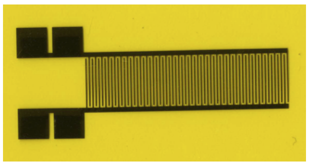

Figure 1: A photograph of a gold electrode.

When bacteria grow in number, charged particles are produced which enables the detection of bacterial growth with electrical measurements. Gold electrodes, illustrated in figure 1, was used to monitor the electrical conductivity of minced meat. Samples of the meat was regularly taken and the number of bacteria was determined, usually given in so called "Colony Forming Units" per gram meat (CFU/g). Theory shows that the bacterial growth starts with the bacteria adapting to the surroundings, the lag phase. Thereafter they start to reproduce by cell division and the number of bacteria increases, which is the log phase. When the reproduction and death rate are equal the increase stops (stationary phase) and later the nutrients in the meat becomes too low and the death phase begins. The bacterial growth is illustrated in figure 2.

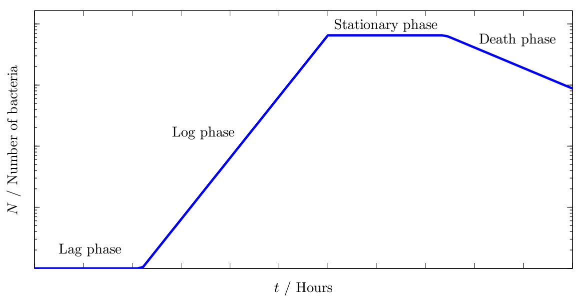

Figure 2: The bacterial growth curve.

The results of the minced meat measurements showed large variations between electrodes and a correlation was not found. However, measurements showed that the measurement principle could be used to monitor bacterial growth. The results of bacterial determination was reliable, since packages of meat stored under the same conditions showed similar amount of bacteria. A result from the impedance measurements done with a gold electrode on minced meat are presented in figure 3, which shows a possible response to bacterial growth. The meat was stored at 13°C and the measurements were done during seven days.

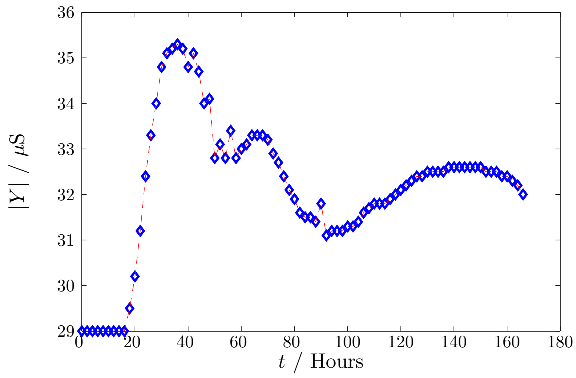

Figure 3: Result from measurements on minced meat at 13°C. The plot illustrates the admittance change over time. The admittance describes how well the conductivity is for alternating signals.

Sensor electronics were designed and by connecting it to a display the measurement result could be presented. Measurements were made on standard electronic components, of the same magnitude as the impedance of the minced meat and compared to the result of a reference instrument. The accuracy of the sensor electronics showed a maximum error of 4% in measurements on resistors and 12.5% on capacitors.

Conclusions

The minced meat measurements only showed similarities to the bacterial growth curve during the first 35 hours. After 35 hours it should enter stationary phase and later on death phase, which was not seen. However, there are other effects on the meat, such as decomposition, which have been investigated.

Further development of the sensor could realise a future integration into the meat package.