УДК 544.653.2/.3, 579.678

SOFT HYDROGEL ACTUATOR FOR FAST MACHINE-LEARNING-ASSISTED BACTERIA DETECTION

Lavrentev F.V.[1], Ivanov A.S.[2], Shilovskikh V.V.[1]
Research supervisor – Ph.D., Prof. Skorb E.V.[1]
[1] ITMO University, Lomonosova str. 9, St. Petersburg 191002, Russia
[2] National University of Singapore, Singapore, 117575 Singapore

Fast and accurate analytical methods are needed to monitor food safety and identify any unwanted contaminants or pathogens that may pose a significant health risk. Traditional methods are limited by time delays in analysis, costly and time-consuming sample preparation, and the need for highly skilled workers. Thus, the rapid development of electrochemical sensors has contributed to significant advances in the quantitative detection and screening of food contaminants and has demonstrated incredible potential as a means of overcoming such limitations. And the combination of analytical methods with machine learning methods provides high analytical accuracy in complex food matrices.

We propose using the current-voltage (I−V) characteristics at the interface between the eutectic gallium-indium alloy (eGaIn) electrode and the hydrogel to detect *Streptococcus thermophilus* and *Bacillus coagulans* bacterial concentrations in the range from 10^4 to 10^8 CFU/mL.
Any suspension with bacteria can be analyzed by statistically measuring its electrochemical behavior using the cyclic voltammetry method. Due to the formation of various redox states at the electrode-electrolyte interface, different signals will occur on the I-V curves. Analysis of the data obtained may indirectly indicate the presence of a certain number of bacteria. For the full spectrum of generation of redox states, it is necessary to use an electrode material capable of electric current-induced polymorphic transition in a given voltage range. One such material is eGaIn alloy, which consists of 75 wt % Ga and 25 wt % In. This alloy has been successfully used to create flexible electronics due to its low melting point, high electrical conductivity, non-toxicity, and low saturated vapor pressure. Gallium is quickly passivated in air, forming a thin oxide film on its surface, which has a higher resistivity than pure metal. This electrochemical approach has a clear advantage over plate counting because it is easier, faster, and can reduce human error.

We have proposed a soft biomimetic monitoring device that can detect bacteria of various concentrations. This actuator can be used to determine the concentration of a wide range of bacteria. Our approach is essential for microbiological analyzes at various levels. The main advantage is to use a one-time collected database and machine learning algorithm, that avoids calibration every time.

Lavrentev F.V. (author)

Skorb E.V. (research supervisor)