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The longevity of phage to *Salmonella typhimurium* on a magnetostrictive sensor platform

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ABSTRACT

Phage was immobilized onto the sensor using physical adsorption and stored at temperatures of 25ºC (room temperature), 45ºC and 65ºC, respectively, and then the longevity of phage to *Salmonella typhimurium* was investigated by studying the binding activity using a magnetostrictive platform at a predetermined schedule. Changes in the fundamental resonance frequency of sensors after exposure to 1 mL of 1×10^9cfu/mL of *S. typhimurium* were recorded over the testing period. The shift in resonance frequency was attributed to the binding of bacteria to phage immobilized sensor, which was confirmed by Scanning Electron Microscopy (SEM) micrographs. The results showed that at each temperature, the binding ability to *S. typhimurium* decreased dramatically at the first 3 days, then decreased very slowly over the testing period, and the longevity of phage on the magnetostrictive sensor platform was longer than 30 days at all tested temperatures. Therefore, it is reasonable to get the conclusion that phage immobilized sensors will be quite suitable to use in field assay at high temperature due to its very good stability.

KEYWORDS

Magnetostrictive;
Biosensor;
Phage;
Salmonella typhimurium;
Longevity.

INTRODUCTION

A biosensor essentially consists of two main components viz., a physical transducer and a biorecognition element. In this study, phage-based magnetoelastic (ME) biosensors have been developed for Salmonella detection. A magnetostrictive platform was served as the transducer, since it offers wireless or remote detecting, which is a unique advantage over conventional sensor platforms, E2 phage was used as the biorecognition element, which has been verified to be highly specific and selective towards *S. typhimurium*[1, 2], and was immobilized on the surface of the sensors using physical adsorption.

For all practical applications, it is very essential for both major components to be robust enough to withstand the rigors of the field conditions. However, in most cases, the biorecognition element is quite susceptible to

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suffer the changes of the field environment. Hence it is of utmost importance to test the thermal stability of the bio-recognition element. In this work, the stability of phage immobilized magnetostrictive sensors was investigated at three different temperatures, 25ºC (room temperature), 45ºC and 65ºC.

MATERIALS AND METHODS

Materials

METGLAS® 2826MB alloy was used as the sensor platform, its theoretical value of the saturation magnetostriction is 12 ppm [3]. E2 phage (1mg/mL) was purchased from Abcam Inc (Cambridge, MA) and *S. typhimurium* cultures were prepared in the Department of Life Science at Auburn University.

Sensor platform

Due to the magnetoelastic nature of the amorphous magnetostrictive alloy, the sensor exhibits a physical resonance when it undergoes a time-varying magnetic field, thus emitting magnetic flux, this can be monitored remotely without the use of direct physical connections [4]. Schematic illustraton of the wireless nature of the magnetostrictive biosensors was shown in Figure 1.

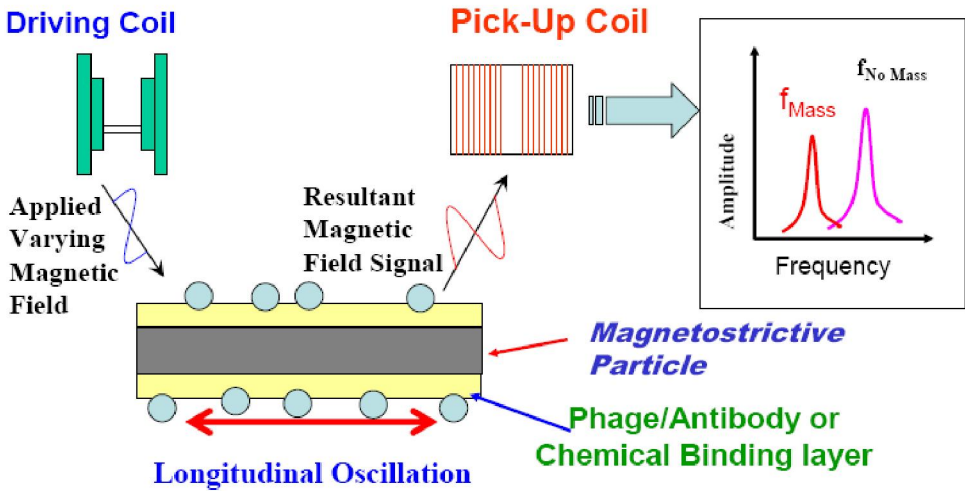

Figure 1 : Schematic illustraton of the wireless nature of the magnetostrictive biosensors

Experimental

After phage immobilization, the sensors were divided into 3 sets and maintained in 3 constant temperature humidity chambers with temperature of 25ºC, 45ºC and 65ºC, respectively. At the predetermined schedule, they were immersed in 1 mL of 1×10^9 cfu/mL of *S. typhimurium* in water for 30 minutes to bind bacterial cells. The resonance frequency of the sensors was measured using a HP network analyzer 8751A with S-parameter test set at 87511A before and after binding of bacterial cells. Finally, SEM images were examined using JEOL 7000F, operating at 5kV.

RESULTS AND DISCUSSIONS

Long-term stability tests

Figure 2 shows the longevity of Magnetostrictive biosensor. It indicates that all sensors at tested temperature exhibited duration dependence and a decline in sensitivity with duration was observed.

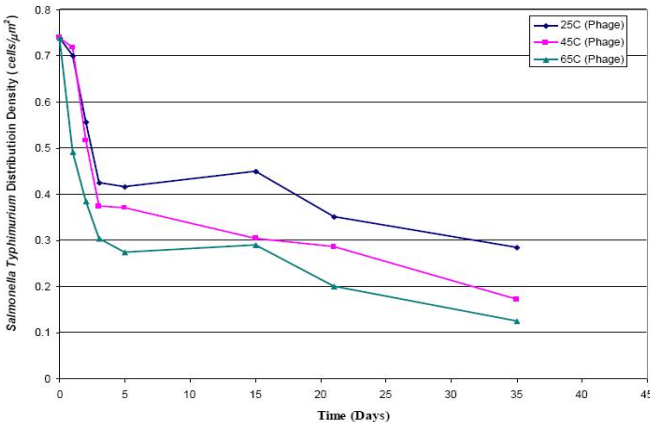

Figure 2 : The longevity of Magnetostrictive biosensors at different temperatures

Scanning electron microscopy (SEM)

Figure 3 shows some typical SEM images of the

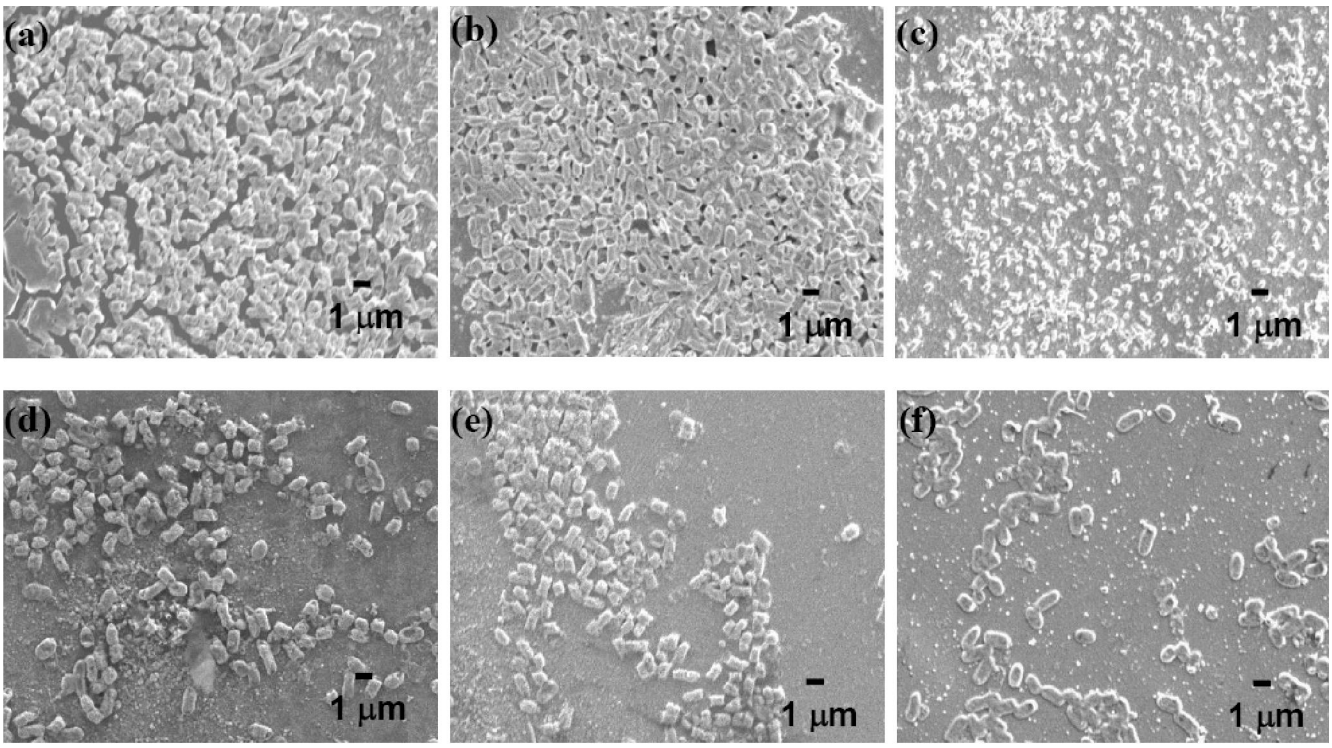

Figure 3 : Typical SEM images of *S. typhimurium* bacterium bound to the phage immobilized biosensor surface after different duration at different temperatures (a) to (c) Day 0 at 25ºC, 45ºC, 65ºC, respectively, (d) and (f) Day 30 at 25ºC, 45ºC, 65ºC, respectively

biosensors with the size of 5mm x 1mm at different temperatures after exposed to the same concentration of *S. typhimurium*, which showing the varying bacterial density on the sensor surfaces with duration at different temperatures.

CONCLUSIONS

The longevity of phage to *Salmonella typhimurium* at different temperatures based on a magnetostrictive platform was studied. The results showed that the longevity of phage on the magnetostrictive sensor platform was longer than 30 days at all tested temperatures. Therefore, phage immobilized sensors are quite suitable to use in field assay at high temperature due to its good stability.

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