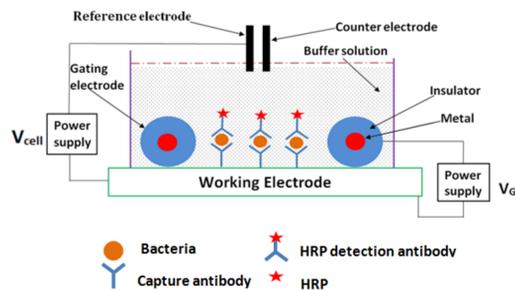


Introduction

- Combating infectious diseases requires rapid detection of single-digit CFUs of infectious bacteria.
- Current detection methods are PCR and ELISA, which require a 7-24 hour culture-based enrichment of samples.
- The diagnosis of bacteremia/bloodstream infections employs culture to detect bacteria at the level of 10 CFU/mL.
- Culture requires at least 48 hours, during which wide-spectrum antibiotics are prescribed for temporary treatment.
- Overuse of broad-spectrum antibiotics leads to the prevalence of antibiotics-resistant bacteria.

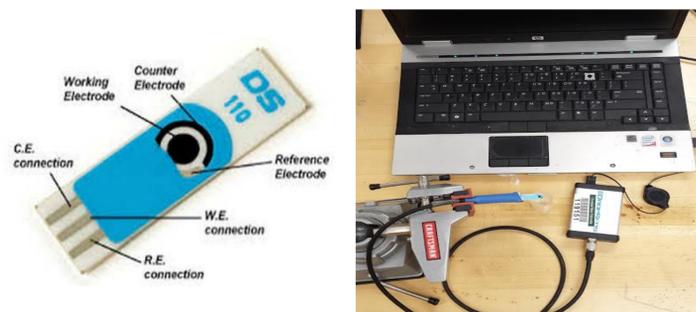


Detection technique



- A three-electrode electrochemical cell modified with insulated gating electrodes for applying a gating voltage V_G .
- V_G provides signal amplification

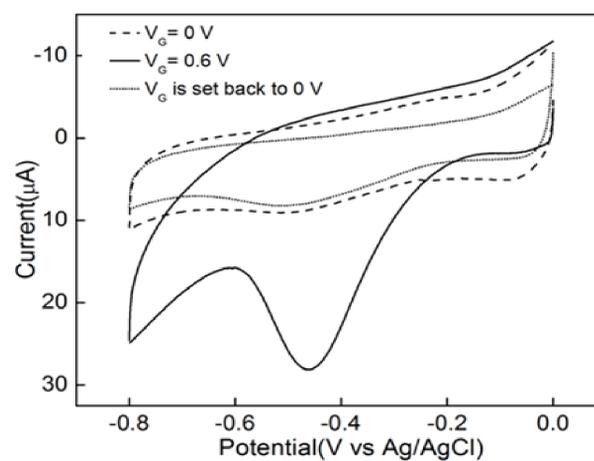
Detecting electrodes



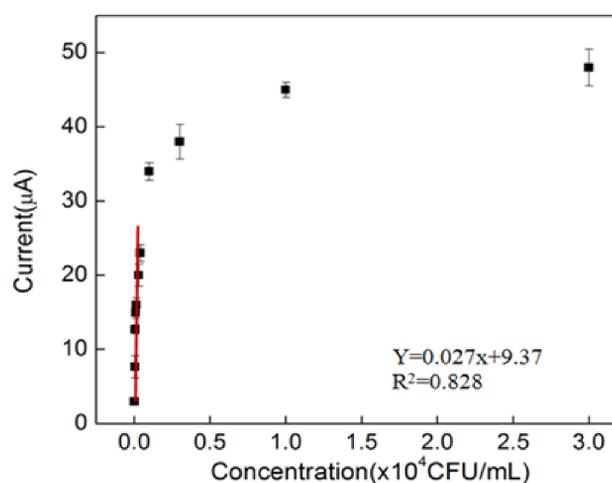
- Screen printed electrodes (SPEs) are used as the detection electrode for low-cost, disposable and point-of-care use.
- Cyclic voltammograms are generated using a potentiostat.
- The reduction peak current of the enzyme is used as the detection signal.

Detection of *Shigella* in blood

- *Shigella*, a rod-shaped bacteria, is the causative agent of shigellosis, an infectious disease with symptoms of bloody diarrhea and fever.
- Shigellosis may lead to bacteremia.
- Inactivated *Shigella* was spiked in whole human blood.
- Detection of *Shigella* was performed directly in blood.
- Each detection was completed in 78 min.
- The detection limit is 18 CFU/mL.



Signal amplification



Calibration curve

Statistical nature of detection – detection at the single-digit CFU level

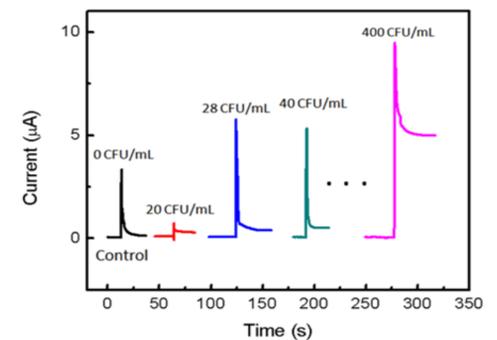
Volume	Concentration				
	20 CFU/mL	50 CFU/mL	70 CFU/mL	100 CFU/mL	150 CFU/mL
50 µL	0/4 (0)	4/7 (0.57)	3/4 (0.75)	3/3 (1)	3/3 (1)
	1 CFU	2.5 CFU	3.5 CFU	5 CFU	7.5 CFU
100 µL	1/4 (0.25)	5/7 (0.71)	4/5 (0.8)		
	2 CFU	5 CFU	7 CFU		

- Below 100 CFU/mL, randomness in the detection occurs.
- The success of detection improves as the sample volume is increased.
- Detection of single-digit CFU.

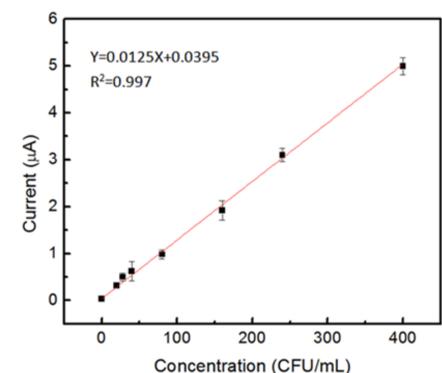
- The single-digit CFU detection suggests the feasibility of direct detection of bacteria without performing culture, leading to rapid detection of bacteremia.

Detection of *E. coli* in milk and meat juice

- *E. coli* is a foodborne infectious bacteria
- *E. coli* outbreaks occur frequently world-wide.
- Detection of *E. coli* is a major task in food safety
- *E. coli* O157:H7 was detected with a detection limit of 20 CFU/mL in milk, 19 CFU/mL in meat juice



Amperometric detection



Calibration curve

Conclusions

- The featured immunosensing system with voltage-controlled signal amplification is capable of detecting single-digit CFU bacteria in 78 min.
- Detection works with different matrices.
- The technique provides inexpensive detection for point-of-care applications.
- The system shows the potential of detection of bacteria in samples without performing culture, leading to rapid detection of infectious diseases.

Acknowledgement

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References

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3. J. Wang and S.-T. Yau, Analytical Methods, 6, 5387-5391(2014).