

Biosensing and Healthcare Applications via Emerging Nanomaterials

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Eurosenors_Summary: The project focus on the fluorescence biosensing via Fluorescence Resonance Energy Transfer (FRET) mechanism based on the fluorescence quenching and recovery. There have been several reports based on the applications of transition metal chalcogenides (TMDs) 2-Dimensional nanosheets (2D-NSs) for FRET based fluorescence-based sensing for varieties of Nucleic Acid, proteins, food toxins, pesticides, and wide varieties of biomolecules, etc, [1-4]. But the application of fluorescence biosensor in physiological or real samples is a big challenge because of the interference from the complex matrix of sensing medium. To solve this issue, the present study focuses on the introduction of antifouling agent (polyethylene glycol) in the biosensing system. The polyethylene glycol modification enhances the stability and detection sensitivity by preventing the aggregation of 2D-NSs and minimizing the interferences in the complex matrix. TMDs single crystals have been grown via chemical vapor transport method followed by exfoliation to form nano-sheets via ultrasonication method and then PEGylated nanosheets were prepared. Then, multiplexed detection of aflatoxins in diverse complex sensing mediums based on the high fluorescence quenching abilities and affinities towards the aptamers was demonstrated via PEGylated nanosheets. Aflatoxins are fungal toxins which not only contaminate food, but also adversely affect human health if consumed and function as biomarkers for liver cancer and other dreadful diseases. The designed sensor demonstrates a multiplexed detection, ultrasensitive (limit of detection in picomolar), wide span of linear working range (around 5 orders of analyte concentrations), target selectivity, quick detection and cost-effective method. Consequently, the designed strategy is highly promising not only for the food industry, but also for the clinical diagnosis of numerous disease (such as cancer) biomarkers in physiological environments. Overall, our project focuses on food and health safety and overall well-being of society. Hence this project provides a substantial footstep and extensive impact on practical healthcare and fundamental research. Inspired by the above research, our future work is to focus on employment of 2D materials-biopolymer for the development of portable point of care device and wearable biosensor for the early detection of cancer and other dreadful disease and for the development of intelligent and sustainable food packaging system for food and health safety.

Eurosenors_Keywords: Fluorescence biosensing, 2-Dimensional nanosheets, antifouling agent, ultrasensitive, selective.

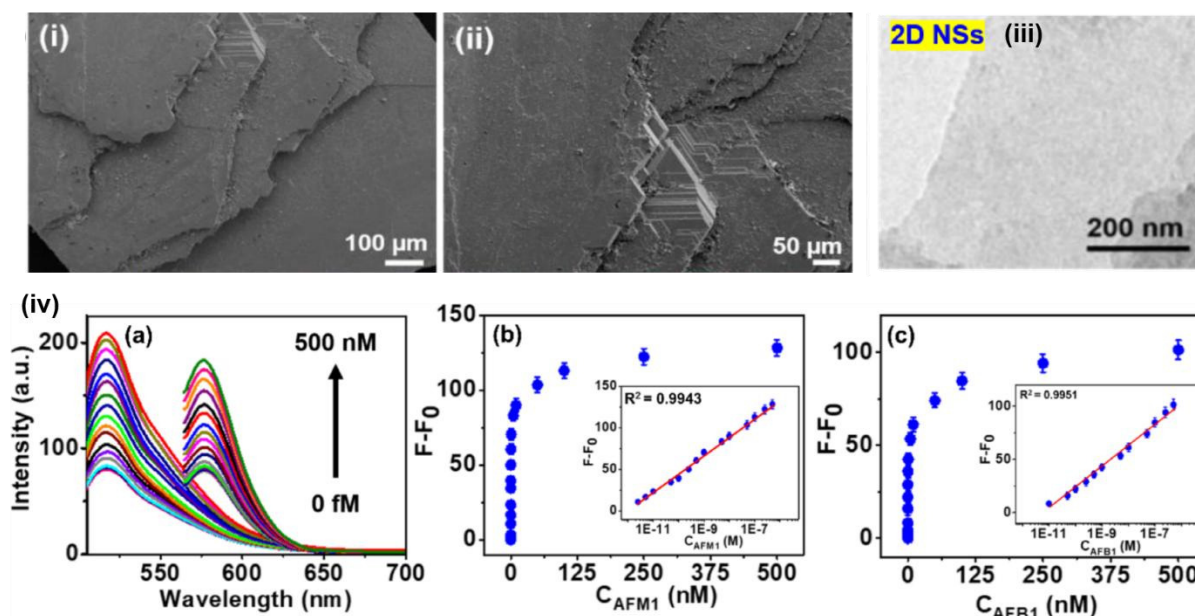


Fig.1 (i, ii) SEM of transition metal chalcogenides bulk crystal (iii) TEM of transition metal chalcogenides nanosheets, (iv) (a) Fluorescence spectra of Fam-Apt-M1 and Tam-Apt-B1 with varying concentrations of AFM1 and AFB1, respectively in PBS for multiplexed sensing via 2D NSs. Fluorescence intensity response (F-F0) of (b) Fam-Apt-M1 and (c) Tam-Apt-B1 versus C_{AFM1} and C_{AFB1} , respectively. Inset in (b, c) shows the plot of (F-F0) versus C_{AFM1} or C_{AFB1} , respectively to determine the LOD and LWR.

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