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ARTICLE

A simplified point-of-care testing approach for preeclampsia blood biomarkers based on nanoscale field effect transistors

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Thuy Thi Thanh Pham,[a] Duy Phu Tran,*[a] Minh Cong Nguyen,[a] Mohamed Taha Amen,[a] Marnie Winter,[a] Clare Whitehead,[b] Justine Toh,[c] and Benjamin Thierry*[a]

[a] Future Industries Institute and ARC Centre of Excellence in Convergent Bio-Nano Science and Technology, University of South Australia, Mawson Lakes Campus, Mawson Lakes, South Australia 5095, Australia

[b] Department of Obstetrics and Gynaecology, University of Melbourne, Parkville, Victoria 3052, Australia

[c] Women's and Children's Hospital, Adelaide, South Australia 5000

*Corresponding author: E-mail: benjamin.thierry@unisa.edu.au and duy.tran@unisa.edu.au

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1. Measurement set-up and electrical characterization

To read the indium oxide nanoribbon FET sensor chips, a compact printed circuit board (PCB) head stage was built with two ZIF integrated circuit sockets, allowing for sequential measurement of up to 2 sensors. The PCB head stage was fitted into a mini Faraday box (W: L = 25: 15 cm) designed for mitigating low frequency noise and light irradiation during measurements. The head stage was electrically connected to a semiconductor analyser (Keysight 2902A, US) using triaxial cables and the data was transferred via a high-speed USB connection to a PC. Current-voltage characterizations of the indium oxide nanoribbon FET sensors were performed in liquid (1x PBS, pH 7.45) at room temperature using an Ag/AgCl micro pellet reference electrode as liquid front gate.

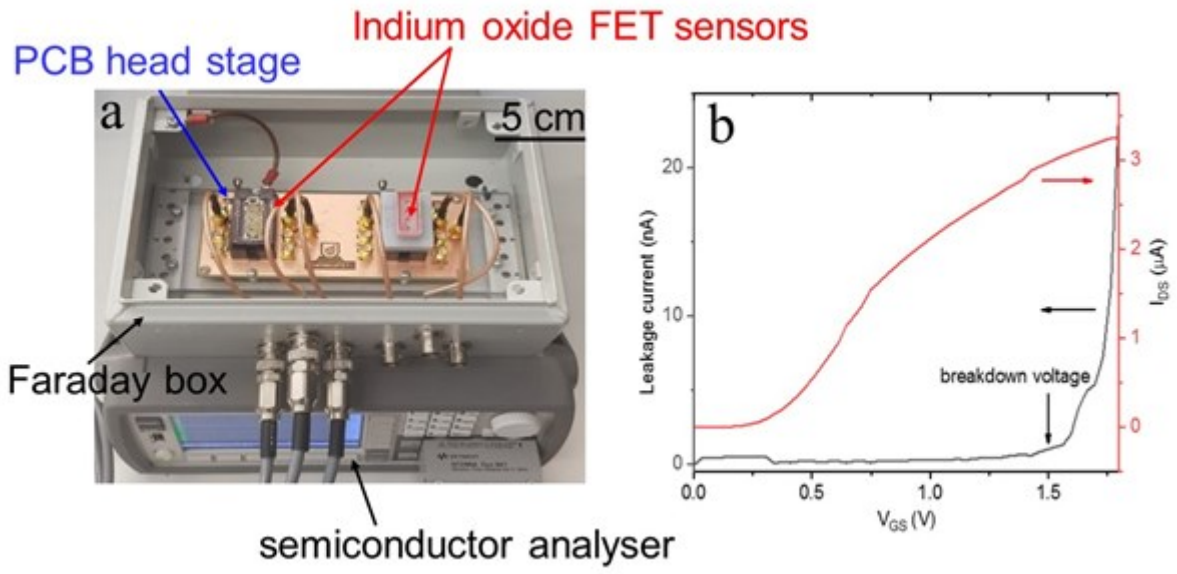
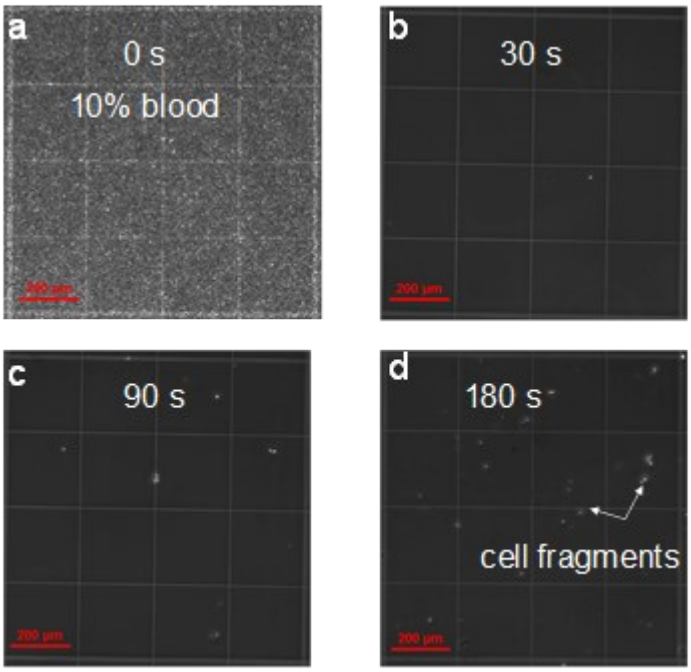


Fig. S1. (a) Photographic image of the measurement setup with in-built head stage for daily liquid testing of indium oxide nanoribbon FET. (b) IDS-VGS transfer characteristics of the indium oxide nanoribbon FET (red curve) with low gate current leakage at ~ pA range (black curve).



2. Microscopic cell counting of filtered plasma

Fig. S2. Microscopic images of 10% diluted blood and plasma after 30 – 90 – 180 seconds of filtration in a 3D printed cartridge. Blood cells fragments can be seen after 90 s.

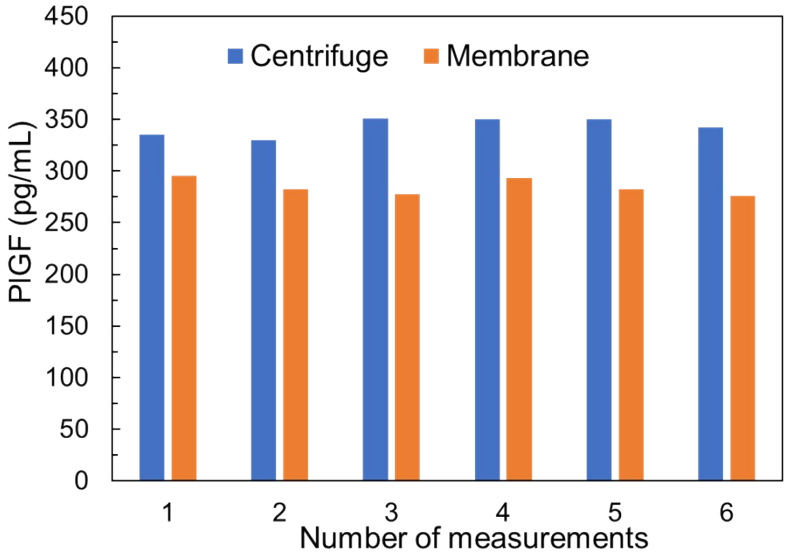


Fig. S3. Reproducibility of PlGF concentration in plasma filtered through membranes (orange columns) vs. centrifuged plasma (blue column) measured using ELISA (PlGF was spiked in 10% diluted blood samples).

Blood sampling accuracy *vs*. dilution factors in a group of untrained users

In order to investigate the preanalytical errors caused by our blood sampling protocol, 4 groups of untrained users (6-9 users per group) who had not previously performed this method were recruited. Different dilution factors from low to high (3x, 6.6x, 24x and 65.6x) for small amounts of blood (15 – 75 µL) were examined. Blood samples were first spiked with a known amount of PlGF (823.6 pg/mL as measured by the Quantikine ELISA immunoassay, R&D system, US). 1x PBS buffer (pH 7.45) and disposable capillary blood tubes were used to dilute the blood sample. A 2-steps user manual was prepared and provided to the users. Briefly, different type of capillary samplers (15 – 40 – 75 µL; PTS Diagnostics, US) were used to take a specified volume of the PlGF spiked blood sample and then applied directly to the blood-to-plasma processing module (step 1). Depending on the dilution factors, different volumes of 1x PBS buffer were then immediately applied to the module using disposable Pasteur transfer pipette with predefined volume as shown in Table S1 (step 2).

Table S1. Table of dilution factors using capillary samplers and Pasteur transfer pipettes

Dilution factors	Capillary blood volume (µL)	PBS buffer volume (µL)
3X	75	150
6.6X	40	225
24X	40	920
65.6X	15	970

After 5 minutes, the plasma from each dilution factor was collected and PlGF concentrations were determined using Quantikine ELISA immunoassay. The sampling accuracy (in percentage %) was calculated from the measured PlGF concentrations prepared by the users taking into consideration the dilution factor.

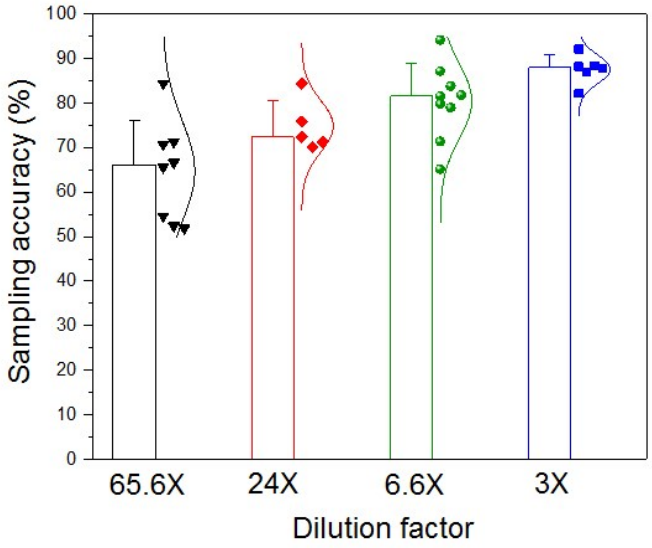


Fig. S4. Scattering plot of blood sampling accuracy *vs*. dilution factors prepared by untrained users.

3. Shelf-life characterization of the vacuum dried nanoscale sensors

In order to investigate the shelf-life stability of the indium oxide nanoribbon FET sensors, they were vacuum packaged according to the protocol described in the Experimental: Surface functionalization of the FET sensor. The vacuum-packed FET sensors were stored at room temperature (~21-25oC) until use. Electrical measurements of the dried indium oxide nanoribbon FET biosensors were conducted using 15 pg/mL PlGF spiked in 10% serum. The degradation of the sensing performance upon storage was normalized to prepared sensor (1-day storage).

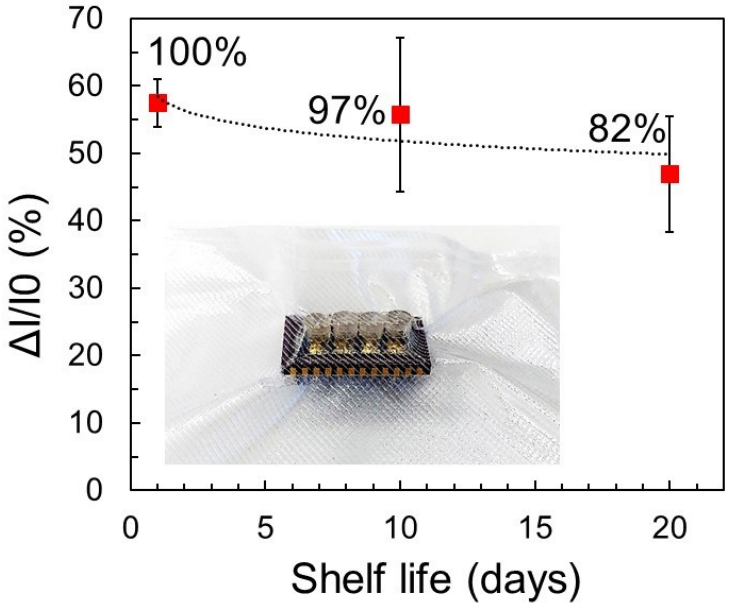


Fig. S5. Measurement responses of dried indium oxide nanoribbon FET sensor (ΔI/I0, %; triplicate independent measurements for 15 pg/mL PlGF spiked in 10% serum) over storage time. Insert is a photograph of a vacuum-packed indium oxide nanoribbon FET sensor.