

Interfacial Biosensing: A new tool for sensing cancer biomarkers

Emtiaz Ahmed, Karthik Balaji Shanmugasundaram, Alain Wuethrich, Laura Carrascosa, Matt Trau and Abu Ali Ibn Sina*

Theme/Topic: Sensors and Imaging

Corner College and Cooper Roads (Bldg 75), St. Lucia, QLD 4072
Australian Institute for Bioengineering and Nanotechnology, The University of Queensland
Brisbane, Queensland, Australia
Email: a.sina@uq.edu.au

Interfacial biosensing is an emerging research field which harnesses the differential adsorption interactions of biological species (e.g. DNA, RNA, proteins) with bare metal surfaces for direct biomolecule detection and analysis.^{1,2} During disease progression, biomolecules commonly undergo considerable changes in their molecular structure and three-dimensional conformation, as compared to their normal states.^{1,2} This can significantly alter the biomolecules' physicochemical properties to affect adsorption interactions with metallic surfaces. Interfacial biosensing innovatively exploits the adsorption behaviour of biomolecules in a novel fashion to enable a new age of clinical translation-directed technologies for genomic, transcriptomic and proteomic analysis. More importantly, it can overcome major technological drawbacks of current biosensing approaches by i) obviating the need for surface biofunctionalization steps and ii) significantly reducing the analysis time and assay cost.^{1,2} Over the last 10 years, we have extensively explored this unique sensing approach and developed many optical, electrochemical and microfluidic sensors for detecting different cancer biomarkers such as DNA methylation, microRNA and protein phosphorylation.³⁻¹⁰ The most exciting one includes the Methylscape Multi-cancer early detection test based on interfacial biosensing which utilizes the universal DNA nano-signature to identify the cancer DNA from any tissue type e.g blood or biopsy.³ This presentation shall review these developments highlighting the applicability of interfacial biosensing via bare gold-biomolecule affinity for detecting cancer associated biomolecular changes. We anticipate that the simplicity of this method, along with the high level of accuracy for identifying the disease associated biomolecular changes could find broad application in biology and diagnostics.

Reference

- ¹Sina, A. A. I.; Koo, K. M.; Ahmed, M.; Carrascosa, L. G.; Trau, M. In: Wandelt, K., (Ed.) Encyclopedia of Interfacial Chemistry: Surface Science and Electrochemistry, **2018**, Elsevier vol. 7, pp 269–277.
- ²K. M. Koo, A. A. I. Sina, L. G. Carrascosa, M. J. A. Shiddiky, M. Trau, *Analytical Methods*, **2015**, 7, 7042-7054.
- ³A. A. I. Sina, L. G. Carrascosa, L. Ziyu, Y. S. Grewal, A. Wardiana, M. J. A. Shiddiky, R. A. Gardiner, H. Samarasinghe, M. Gandhi, R. Scott, D. Korbie, M. Trau, *Nature Communications*, **2018**, 9, 4915.
- ⁴A. Wuethrich, A. A. I. Sina, M. Ahmed, T-Y. Lin, L. G. Carrascosa, M. Trau, *Nanoscale*, **2018**, 10, 10884-10890.
- ⁵A. A. I. Sina, L. G. Carrascosa, R. Palanisamy, S. Rauf, M. J. A. Shiddiky, M. Trau, *Anal. Chem.* **2014**, 86, 10179–10185.
- ⁶Sina, A. A. I., Lin, T-Y., Vaidyanathan, R., Wang, Z., Wang, J., Dey, S. Behren, A., Wuethrich, A., Carrascosa, L. G., Trau, M. *Nanoscale Horizons*, **2020**, 5, 1317-1323
- ⁷Ahmed, E., Masud, M. K., Hossain, M. S. A., Na, J., Sina, A. A. I.,* Yamauchi, Y., Trau, M. *Analyst*, **2020**, 145, 6639-6648.
- ⁸Ahmed, M., Wuethrich, A., Constantin, N., Shanmugasundaram, K.B., Mainwaring, P., Kulasinghe, A., O'Leary, C., O'Byrne, K., Sina, A. A. I.,* Carrascosa, L. G., and Trau, M. *Analytical Chemistry*, **2023**, 95, 8522–8532.
- ⁹Shanmugasundaram, K. B., Ahmed, E., Miao, X., Kulasinghe, A., Fletcher, J. A., Monkman, J., Mainwaring, P., Masud, M. K., Park, H., Hossain, M. S. A., Yamauchi, Y., Sina, A. A. I.,* O'Byrne, K., Wuethrich, A., Trau, M. *ACS Sens.* **2024**, 9, 3009–3016.
- ¹⁰Masud, M. K., Sina, A. A. I. et. al. Ultra-Sensitive Mesoporous Gold Biosensor for MicroRNA Detection at Attomolar Level. *Biosensors and Bioelectronics*, **2020**, 168, 112429.