Single-Cell Analysis Using Oil-Free Cell-Sorting *d*I-ICP-MS

Yang Zhou, Rong Yuan, Juxing Zeng, Yong Liang, Xiaowen Yan, Bo Zhang, Limin Yang, Qiuquan Wang*

Department of Chemistry & the MOE Key Lab of Spectrochemical Analysis and Instrumentation, Xiamen University, Xiamen 361005, China

Gold statement

- Single-cell analysis on ICP-MS
- Oil-free cell-lined up direct infusion ICP-MS platform
- Discover the different applications available for this new platform

Introduction

It is crucial to manipulate cells into a lined up single cells with controllable interval time for single-cell analysis using inductively coupled mass spectrometry (ICP-MS) due to its advantage of converting molecules even intact cells into simple atomic ions, on the other hand, its disadvantage being not able to distinguish the atomic ion mass signals from which molecules and/or cells. However, when coupled online with ICP-MS, widely applied water-in-oil droplet-based microfluidics for single cell analysis met problems. For example, the oil phase rumpled the stability, efficiency, and accuracy of ICP-MS, and the conventional interface between ICP-MS and the microfluidic chip suffered the low sample introduction efficiency, as well as the transportation rates sometimes unmatched the readout dwell times for transient signal acquisition.

Body

In this communication, we report an oil-free passive microfluidic system (OFPMS) that consists of alternating straight-curved-straight microchannels and a direct infusion (*d*I) micronebulizer for ICP-MS of lined-up single-cell considering cells are already “droplets” with hydrophilic surface and elastic hydrophobic membrane. OFPMS guarantees exact single cell isolation one by one just using a thermo-decomposable NH_4HCO_3 buffer, eliminating the use of any oil and incompatible polymer carriers. It is more flexible and facile to adapt to the dwell time of ICP-MS owing to the adjustable throughput of 400 to 25000 cells/min and the controllable interval time of at least 20 ms between the lined-up adjacent single cells. Quantitative single-cell transportation and high detection efficiency of more than 70% was realized using OFPMS-*d*I-ICP-MS [1]. Furthermore, in order to meet the requirement of sensitivity, lanthanide (Ln)-encoding signal amplification and multiplication strategies were also developed for single-cell (bacterium and virus) analysis [2.3].

Conclusion

The OFPMS-*d*I-ICP-MS together with Ln-encoding signal amplification and multiplication strategies found its applications to single-cell (bacterium and virus) analysis. Qualitatively recognization and quantitatively counting of a single cell and/or bacterium as well as their membrane marker molecules can be achieved.

References

[1] Y. Zhou, Z. Q. Chen, J. X. Zeng, J. X. Zhang, D. X. Yu, B. Zhang, X. W. Yan, L. M. Yang, Q. Q. Wang, *Anal. Chem*. **92** (2020) 5286-5293.
[2] R. Yuan, F. C. Ge, Y. Liang, Y. Zhou, L. M. Yang, Q. Q. Wang. *Anal. Chem.* **91** (2019) 4948-4952.
[3] Y. Liang, Q. Liu, Y. Zhou, S. Chen, L. M. Yang, M. Zhu, Q. Q. Wang. *Anal. Chem*. **91** (2019) 8341-8349.