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An in-source helical membrane inlet single photon ionization time-of-flight mass spectrometer for automatic monitoring of trace VOCs in water

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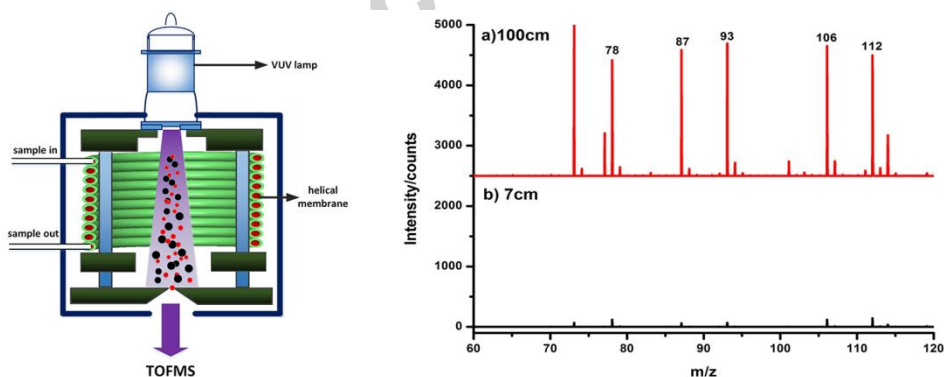
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ABSTRACT

An in-source, helical membrane inlet single photon ionization time-of-flight mass spectrometry (SPI-TOFMS) has been developed to improve the detection sensitivity of trace volatile organic compounds (VOCs) in water. A helical winding membrane and a four-stage differential pumping system of TOFMS was designed to improve and maintain the vapor pressure of analyte, which is linearly associated with the sensitivity of SPI. The helical winding increased the length of the hollow fiber membrane (HFM) from 7 cm to 100 cm and the pressure inside of SPI source was elevated from 3.6 Pa to 28 Pa, and then the sensitivity was increased by 16, 34.7, 32.3, 17.9 and 13.9 times for benzene, ethyl tert-butyl ether (ETBE), aniline, p-xylene, and chlorobenzene (MCBz) respectively. The limits of quantitation (LOQs) of benzene, ETBE, aniline, p-xylene and MCBz were 0.014, 0.143, 0.556, 0.036, 0.025 $\mu\text{g L}^{-1}$ respectively with a measurement time of 50 s, which were enhanced by more than one order of magnitude compared to our previous work (reference [32]). The in-source design of helical winding membrane i.e. putting the membrane inside the SPI source dramatically reduced the response time to 1.33 min. This system has been evaluated for VOCs in sewage water of different laboratory buildings and automatic monitoring the pollutants in sewage water from a biological laboratory building. The automatic continuous analysis of organic pollutants in water has very important significance and broad application prospect for online assessment of water quality.

Graphical abstract



Keywords: in-source; helical membrane; single photon ionization; automatic monitoring; trace VOCs; water

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