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Battelle Number(s):

14158-E, 15270-E, 15625-E, 15815-E, 16720-E

Patent(s) Issued

Available for licensing in all fields

U.S. DEPARTMENT OF ENERGY

Available Technologies

High-Throughput and Ultra-sensitive Multidimensional Analytical Platform Based on Multiplexed Ion Mobility Spectrometry/Mass Spectrometry

SUMMARY

The integration of ion mobility spectrometry (IMS) with mass spectrometry (MS) has recently become a point-of-emphasis for instrument developers because of the potential it offers for improved compound identification of peptides and other compounds having similar atomic masses. However, this potential has been hampered by the losses in sensitivity and duty cycle that are traditionally associated with combined IMS/MS systems. Recently, PNNL has an integrated instrument platform that overcomes these problems. The system incorporates PNNL's patented ion funnel technology for increased sensitivity, the patenting ion funnel trap that builds on the earlier ion funnel technology while also providing precise ion accumulation and release, and a multiplexing feature for increased sensitivity and duty cycle.

The new system is capable of being efficiently coupled with liquid chromatography systems. This is accomplished using the ion funnel trap that enables efficient analysis of species formed in the ionization source and conversion of the continuous stream of ions produced into higher charge density ion packets, and does so without losses of ions. Once spatially compressed ion packets are injected into the IMS drift tube, they experience thermal diffusion and space charge broadening during the IMS separation, phenomena that have previously limited the sensitivity of the resulting measurements. In the platform, the refocusing of the dispersed ion packets into the small inlet of a mass spectrometer is accomplished using ion funnel technology, which accomplishes this step without significant ion losses or degrading IMS resolution.

Multiplexing is a technique that is related to and often confused with a technique known as Hadamard transform. However, the multiplexing technique developed at PNNL is fundamentally different and provides several advantages over Hadamard transform. It involves the use of an extended pseudo random gating procedure that separates ions into packets based upon the timing of the gate openings and closings. After traveling through the drift region of the IMS or TOFMS, ions from different packets are intermingled at the detector due to differences in relative ion mobility. The intermingled ions are then mathematically de-convoluted to yield a higher signal-to-noise ratio than can be produced by conventional signal averaging techniques. Because ion packets can travel through the drift region simultaneously, rather than one at a time, analysis throughput is increased.

For a given sample, multiplexing decreases analysis time by 10-fold at the same

signal-to-noise ratio as the conventional approach. Alternatively, sensitivity can be increased through the use of the technique, while still maintaining faster throughput than conventional methods. Although the algorithms behind multiplexing are relatively complex, implementation of the technique is relatively straightforward, involving the addition of relatively simple electronic gating equipment and software to IMS systems, MS systems or combinations of IMS and MS. The system also incorporates sophisticated software for integrating and controlling the new multidimensional system.

Patents & Intellectual Property

- Patent #: 6,818,890
- Patent #: 6,967,325

Technology Portfolio(s)

- Mass Spectrometry Instrumentation

Potential Industry Applications

- Chemicals
- Healthcare, Pharma, Biotech & Medical
- Professional Services
- Security

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