Polymeric Monolithic Materials For Analytical Applications

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Polymer based monoliths were introduced over 20 years ago. The relatively simple preparation, robustness, high permeability to flow, mass transfer via convection and flexible chemistry has since seen these materials used in a range of applications such as chromatography and as supports for synthesis, catalysis and immobilized enzymes. These same properties make monolithic polymers an excellent choice as materials for sampling and sample preparation, particularly for miniaturized technologies with the potential to produce cleaner extracts and facilitate rapid sample preparation for mass spectrometry (MS).

This presentation will introduce monolithic micro-sampling devices developed for sampling and sample preparation of biological samples, including whole blood. Monolithic micro-sampling devices prepared within disposable pipette tips have been developed for in-tip separation of blood cells from plasma and as immobilized enzyme reactors (IMER) for protein digestion. Subsequent micro-solid phase extraction (µ-SPE) was achieved using high surface area polymer monoliths. The µ-SPE device was then directly hyphenated with both ESI-MS and nanospray-MS. Microextraction by packed sorbent (MEPS) in which the SPE phase is placed within an exchangeable needle hub integrated into an analytical syringe is also demonstrated for µ-SPE. A workflow was developed using the monolith filtration and enzyme reactor technology in combination with an at-line micro SPE-ESI-MS approach enabling both sample preparation and analysis to be completed in < 20 min, facilitating high-throughput sample analysis in a standard bioanalysis workflow. New, high surface area polymeric monolithic sorbents tailored for SPE of small and medium sized molecules will also be introduced and are shown to provide significant advantages over particle-based sorbents, providing greater reproducibility in the sorbent bed. In a further embodiment the selective extraction of small molecules from complex matrices such as plasma will be demonstrated, using new restricted access poly(DVB)-g-PEGMA monoliths.

The majority of this work was undertaken as part of an integrated research program between academic and industry based researchers. This presentation will also demonstrate how using this approach that fundamental research can lead to early translation to new commercial products.