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Foreword

Molecularly imprinted polymers in separation science

This special issue has been prepared to recognise the expanding field of *Molecular Imprinting* and, in particular, the many exciting applications of imprinted polymers in analytical separation science. The main attraction of the technique is its apparent simplicity. In theory, the synthesis of a polymer in the presence of a template molecule and subsequent removal of the template furnishes a robust material with "memory" sites, which have the ability to selectively rebind the original template from a mixture. Furthermore, in principle, molecularly imprinted polymers (MIPs) can be made with selectivity for essentially any of a diverse range of analyte species, such as drug enantiomers, pesticides, hormones, toxins, short peptides and nucleic acids. These polymers can then be employed for separation of the analyte in matrices ranging from pure organic solvents to biological fluids. Experimental reality is, of course, a greater challenge and many laboratories are successfully engaged in research into the understanding of the imprinting process, the development of novel imprinting systems and the use of imprinted polymers in various application areas.

From an analytical separation point of view, a MIP may be best characterised as being a material, which in addition to the imprinted affinity sites contains both polar and lipophilic surface functionality. Thus, retention in chromatographic and membrane separation systems is due to a mixed-mode mechanism involving both selective affinity binding with imprints and non-specific physicochemical adsorption on polymer surface. Accordingly, the optimisation of a MIP-based separation requires a fundamental understanding of the strength and nature of imprint–analyte and polymer surface–analyte interactions, respectively, and how these vary with the type of solvent or buffer employed. Unfortunately, imprint polyclonality prevents us from using simple one-site models for calculation of a single affinity constant and instead more sophisticated models for characterisation of imprint affinity distribution are required. Consequently, while chromatography provides an excellent means for the initial characterisation of MIP selectivity, a more in-depth characterisation of binding affinity distribution requires equilibrium binding experiments over a large range of ligand concentrations.

Trace and ultra-trace analysis of complex biological and environmental samples, often rely on selective sample cleanup prior to a chromatographic separation. Solid-phase extraction (SPE) is currently a frequently used sample preparation technique. Separation on most current SPE materials is based on physicochemical retention on the functionalised surface and the extraction column may retain not only the target analyte(s) but also other matrix components. Affinity separation materials, such as MIPs, potentially offer a higher degree of sample cleanup efficiency and recent years have seen increasing research activity into molecular-imprint-based solid-phase extraction. Membrane separations are important both on analytical and process scales and imprinted membranes will potentially provide improved selectivity over current systems. While not immediately related to the analytical separation area, though of potential clinical importance, the extraction of biologically active compounds from traditional herb medicines and the use of MIPs for drug delivery.

As the emphasis of the present issue may seem to be on the application of MIPs, their successful employment necessitates the availability of materials with appropriate selectivities and physical properties. Therefore, the development of novel and improved MIP systems, as well as a basic understanding of the imprinting process, are fundamental to the further development of the various imprint-based applications. We believe the present issue reflects the exciting and dynamic nature of the field and the collection of reviews and original articles will provide a useful and inspiring source of information.

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