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Foreword

Flow Chemistry: An Enabling Tool for Chemical Synthesis and Manufacture

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The recent decade has realised the emergence of enabling technologies to broaden the toolset available to molecule makers. Enabling technologies are eloquently defined by Kirschning[1] to be methods which contribute to accelerate synthetic transformations, broaden experimental space, and facilitate simple work-up and isolation of products. Indeed, one enabling technology – microwave-assisted organic synthesis – has steadily transitioned from a peripheral curiosity to a ubiquitous technology, commonly seen in academic and industrial synthesis laboratories.

The increasing use of flow chemistry devices and methods in modern synthesis laboratories suggests that flow-based chemistry is poised to impact practical organic synthesis in a similar fashion. Over the course of the last five years, a growing number of publications have demonstrated the advantages of moving from batch to flow mode. Performing reactions in tubes and microfluidic channels enhances reactivity as the contained environment lends itself to the use of increased temperatures and pressures. Similarly, a new cryogenic flow reactor recently described by Ley[2] allows precise control of cold temperatures without problematic water ingress, thereby improving the reaction profile and quality of products from cryogenic transformations. We have seen how toxic and hazardous reagents, along with gases at elevated pressures, can be accommodated safely within microreactor devices in a normal laboratory environment without the safety concerns associated with corresponding batch techniques. This emergent capability to use hazardous reagents in a safe process may allow us to re-examine 'forgotten reagents' that were abandoned due to their unacceptable safety profile. Furthermore, through the use of immobilised reagents, the new discipline has demonstrated improvements in efficiency and reduction of the environmental footprint of synthesis experiments by way of 'telescoping reactions', ameliorating the need for chromatography and reduced solvent use. Finally, the continuous nature of the technique paves the way for scale-up reactions to be performed without the requirement for laborious re-optimisations, thereby saving time and valuable resources. The potential benefits of such an approach to industry are significant.

The rapid emergence and dissemination of flow chemistry techniques into the research laboratory, along with its adoption by industry, warrant the publication of a Research Front on flow chemistry in the *Australian Journal of Chemistry*. I invite you to explore this issue, and the excellent and creative contributions from some of the world's leading groups involved in flow chemistry research. Assembled in this issue are full papers, a communication and a review describing the latest contributions by each group to the emerging field of flow chemistry. The topics range from new applications of flow photochemistry,[3,4] complex multi-step synthesis,[5,6] and the development of novel supported reagents, to microreactors and innovative methods for in-line analysis and real-time monitoring.[7–9] The field is now moving beyond demonstrating the adaptation of known chemical transformations to continuous flow, to embarking on the exploration of new reaction space. Applications involving the safe generation of hazardous reagents or reactive intermediates in microreactors are reported herein.[10–12] Finally, it is particularly noteworthy to see the expansion of continuous flow methods to areas outside traditional organic synthesis. The synthesis and scale-up of functional polymers using multi-stage processes represents an exciting application of this key technology.[13,14] Finally, I draw your attention to a review in this issue focussed on recent work on the use of microreactors to improve chemical production, which undoubtedly will be of particular interest to our industry colleagues.[15]

I would like to extend my sincerest thanks to all contributing authors and colleagues who have taken the time and significant effort to make this Research Front possible. Each has demonstrated immense professionalism in meeting submission deadlines and their efforts have culminated in an exciting collection of the latest research in flow chemistry. I am indebted to the editorial and production team at the *Australian Journal of*

Dr Anastasios (Tash) Polyzos was awarded his Ph.D. in physical organic chemistry in 2005 from La Trobe University (Melbourne, Australia), under the supervision of Associate Professor Andrew B. Hughes. In the same year, he was appointed as Research Fellow at the Commonwealth Scientific and Industrial Research Organisation, CSIRO (Materials Science and Engineering), Australia's national research agency. In 2008, he was appointed as Post-Doctoral Research Associate at University of Cambridge under the guidance of Professor Steven V. Ley, FRS, investigating the synthesis of advanced products using multi-step flow chemistry methods. In 2011, he returned to CSIRO Materials Science and Engineering as Research Scientist, where he played a key role in establishing CSIRO's flow chemistry capability. Tash was also appointed Fellow at the University of Melbourne in 2011. His current research interests include the development of new methods and enabling technologies for the synthesis of complex organic products; in particular, the development of automated multi-step processes, catalysis and reaction discovery.

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