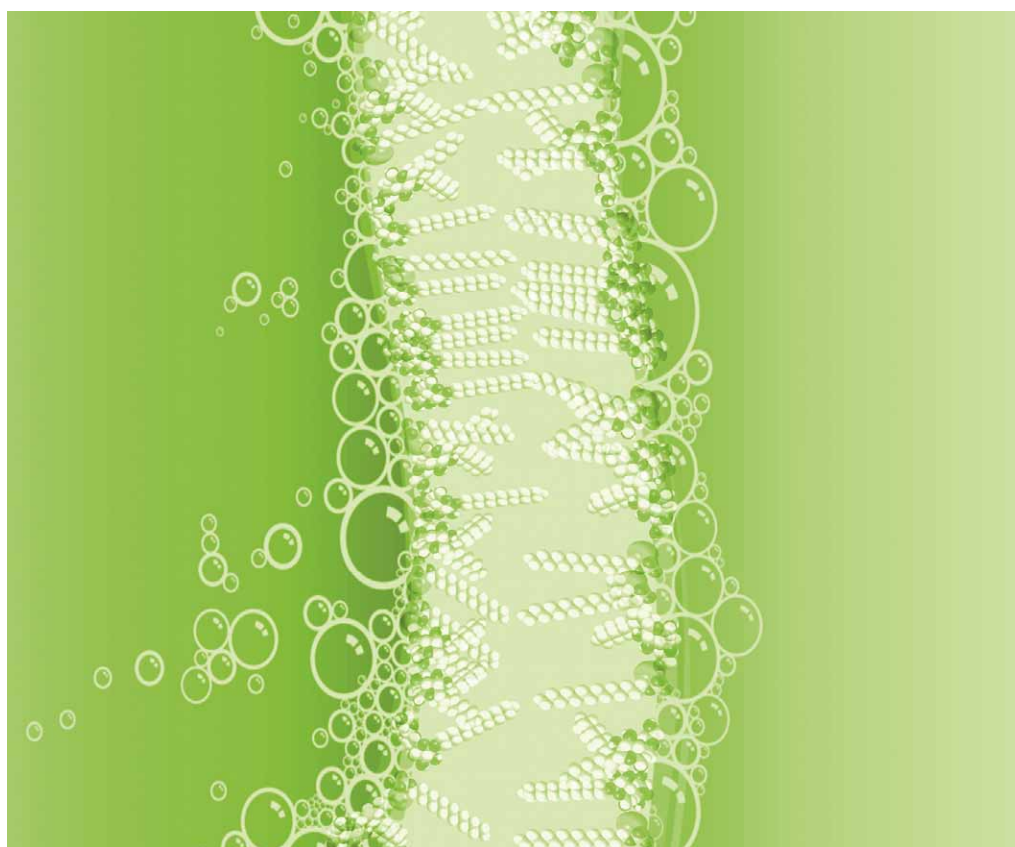


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EDITORIAL

Green Chemistry: present and future†

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Historically, one relies on Mother Nature to provide all the material needs of society. The development of modern chemistry has enabled us to transform our natural resources as well as to create new matter from existing ones to benefit society, which has greatly enriched our modern living and increased the quality of life. The heroic creativity, imagination, and innovation of chemists have touched every corner of our daily life from the colorful clothes that we wear to the ever changing electronic products that we “play” with, from the pharmaceutical agents to combat life threatening diseases to synthetic fertilizers to boost crop production for the world’s needs, from the rapid growing number of skyscrapers to the ever increasing speed of transportation.

However, these enormous chemistry achievements have come with a price. Global natural resources are dwindling rapidly, the wastes accompanying the use and transformation of these resources as well as from chemical products having reached the end of their usefulness are accumulating quickly, some chemical products leading to unwanted properties despite all the good intentions of their

creators. These “side” products of our chemical creations and innovations are increasingly causing environmental, health, and societal concerns. As a result, sustainability has become one of the greatest scientific challenges of our time (Fig. 1). The field of Green Chemistry, created two decades’ ago, represents the key efforts to address such challenges from the most fundamental level by re-examining, redesigning, and recreating the scientific tools in producing, transforming, and utilizing of chemical products to increase the efficiency and efficacy while minimizing waste and harm. The objectives of this themed issue on Green Chemistry by some of the leading researchers on the subject are to reflect the progress, to celebrate the achievements, and to examine our needs in the field. This collection is only a small selective representation of a vast number of exciting developments in the field.

The paper by Gallezot (DOI: 10.1039/C1CS15147A) looks at using alternative chemical feed stocks from non-renewable to biomass while the paper by Darensbourg and Lu (DOI: 10.1039/C1CS15142H) examines the conversion of CO₂ into

useful chemical products; the papers by Rogers (DOI: 10.1039/C2CS15311D), Li (DOI: 10.1039/C1CS15222J), and Poliakov (DOI: 10.1039/C2CS15314A) summarize the creative uses of ionic liquids to process biomass, of water to simplify synthetic steps, and of supercritical CO₂ to enable chemical productions in flow; the paper by Sheldon (DOI: 10.1039/C1CS15219J) discusses reaction design to increase the synthetic efficiency; the papers by Dunn (DOI: 10.1039/C1CS15041C) and Jiménez-González (DOI: 10.1039/C1CS15215G) focus on process developments in chemical productions; the paper by Pelletier (DOI: 10.1039/C2CS15286J) presents examples of using enzymes for chemical transformations; the paper by Varma (DOI: 10.1039/C1CS15204A) looks at alternative energy input to facilitate chemical transformations; and finally, the paper by Beach (DOI: 10.1039/C1CS15217C) looks at greener molecular product design.

We hope that these representative developments will inspire further innovations in the production and utilization of chemical products for a sustainable future.

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† Part of a themed issue covering the latest developments in green chemistry.

Hydrogen economy	Better efficiency	I E M M P E R N O T V S	P T R I V O D E U L C Y	Core ideas	Hetero- geneous catalysis	Hydrogen	Benign	Clean	Neoteric solvents	Omit derivat- isation	Function- alisation	Hetero- geneous catalysis																							
						Low toxicity	Networks for exchange	Function- alisation	Function- alisation	Function- alisation	Function- alisation																								
						Naturally derived	Cleaner processes	Cleaner processes	Cleaner processes	Cleaner processes	Cleaner processes																								
						Kinetics	Global partner- ship	Green energy	Asym- metric synthesis	Separ- ation	Batch reactions	Know- ledge driven																							
Renew- ables	Solvent reduction	Yes, it's safe	Zero emissions	No by- products	Micro- wave heating	Catalytic reagents	Meet the need	Fail-safe mech- anisms	Contin- uous flow	No impurities	Cellulose	Ozone layer	In-process monitoring	Solvent free	Sustain- ability	Micro- reactor Tech	Ionic liquids	Recycle excess energy																	
																			Think innov- atively	Super- critical fluids	Very simple	Reuse	Recover heat	Problem- free disposal	Agri- cultural materials	Commer- cial design	Atom economy	Recycle excess energy							
																			Life-cycle assess- ment	Life-cycle assess- ment	Temper- ature ambient	Water	Renew- able energy	Output- led design	Meta- thesis	Avoid Deriva- tives	Really green	Auxiliary sub- stances	Homo- geneous catalysis	Commer- cial production	Fluorous biphasic	Positive benefits	Polymers	Atom economy	Recycle excess energy
																			Carbon capture & storage	Ambient condi- tions	Degrad- able	Safeguard our future	No Bio- hazards	Highly selective	Good durability	Think big	Design simplicity	Carbon footprint	Biological feed- stocks	Conserve mass	Efficient use	Smart materials	Process monitoring	New designs	Prevent waste
Flow reactors	Real-time analysis	Bulk chemicals	Hazard free	Water	Safeguard our future	No Bio- hazards	Highly selective	Meta- thesis	Avoid Deriva- tives	Really green	Commer- cial production	Fluorous biphasic	Positive benefits	Sustain- ability	Micro- reactor Tech	Ionic liquids	Recycle excess energy																		
																		Yes, it's safe	Zero emissions	No by- products	Micro- wave heating	Catalytic reagents	Meet the need	Fail-safe mech- anisms	Continuous flow	No impurities	Cellulose	Ozone layer	In-process monitoring	Solvent free	Sustain- ability	Micro- reactor Tech	Ionic liquids	Recycle excess energy	
																		Life-cycle assess- ment	Life-cycle assess- ment	Temper- ature ambient	Water	Renew- able energy	Output- led design	Meta- thesis	Avoid Deriva- tives	Really green	Auxiliary sub- stances	Homo- geneous catalysis	Commer- cial production	Fluorous biphasic	Positive benefits	Sustain- ability	Micro- reactor Tech	Ionic liquids	Recycle excess energy
																		Ambient condi- tions	Degrad- able	Safeguard our future	No Bio- hazards	Highly selective	Good durability	Think big	Design simplicity	Carbon footprint	Biological feed- stocks	Conserve mass	Efficient use	Smart materials	Process monitoring	New designs	Prevent waste	Conserve energy	

Fig. 1 A Periodic Table of Green Chemistry, devised by Samantha Tang, Richard A. Bourne, Richard L. Smith and Martyn Poliakoff. The blue and yellow "elements" highlight the ideas in the 24 Principles of Green Chemistry and Engineering IMPROVEMENTS PRODUCTIVELY, see S. Y. Tang, R. A. Bourne, R. L. Smith and M. Poliakoff, *Green Chem.*, 2008, **10**, 268–269.