Close Encounters of Three Reaction Kinds

Martyn Fordham – Asynt MD

Three Growing Areas:

Photochemistry

Flow Chemistry

Electrochemistry

Photochemistry

- Uses light as a catalyst.
- Alters chemical energy states.
- Lower reaction requirements than traditional pathways.

Photochemistry

Important for drug-development & organic synthesis.

- High atom efficiency.
- High energy efficiency.
- Beneficial for stereoselectivity.

Challenges have been:

- Reproducibility.
- Scale-up efficiency.

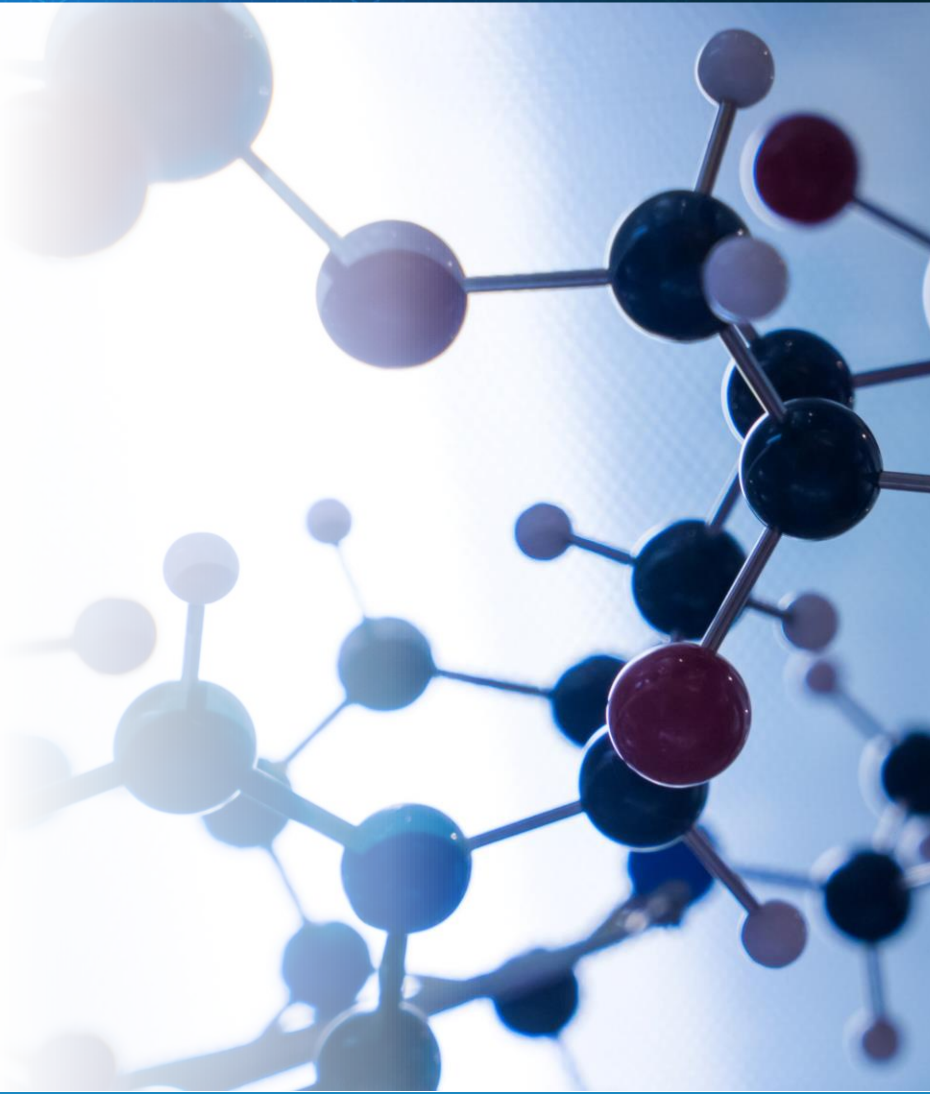
Asynt
By chemists, for chemists

"Homemade" Photochemistry

"Homemade" photoreactors -

- Unreproducible results
- Potentially dangerous

Important surface area / volume ratio
- decreasing reaction efficiency with scale.



www.asynt.com
enquiries@asynt.com
+44 (0)1638 781709

Flow Chemistry

- Alternative to batch chemical production.
- Enables continuous reactions.
- Improved heat transfer via increased surface area / volume ratio.
- Integrates with reaction monitoring systems.

www.asynt.com
enquiries@asynt.com
+44 (0)1638 781709

Flow Chemistry

Important for industrial scale production.

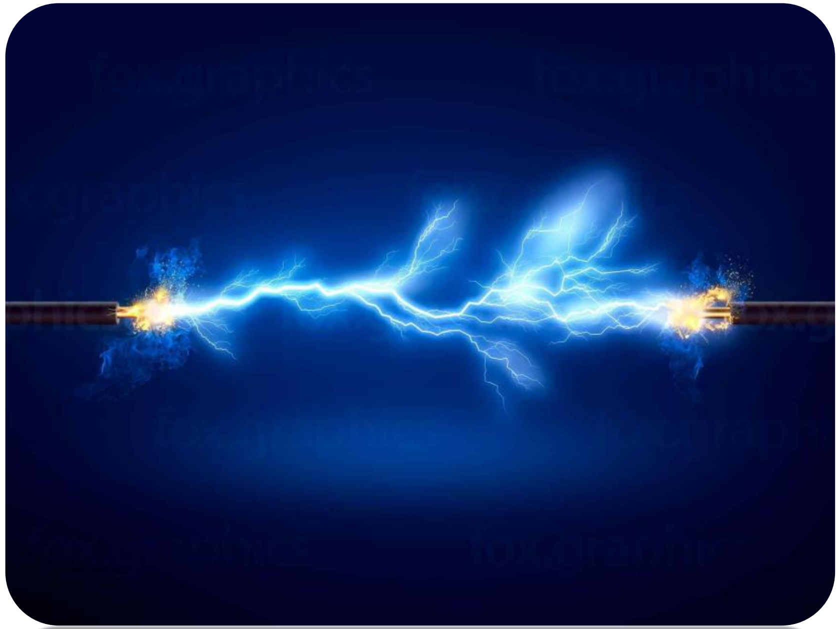
- Safe processing of highly reactive reagents.
- Simulates large-scale production on a smaller scale.
- Reduce energy and reactant waste.

Challenges have been:

- Heterogeneous reactions
- Accessibility.

Electrochemistry

- Uses electrons as a reactant.
- Enables redox reactions with fewer chemical reagents.
- More atom efficient.
- Highly selective reaction pathways.



Electrochemistry

Important for organic chemistry:

- Reduces chemical waste.
- Selective synthesis of novel compounds.

Challenges have been:

- High sensitivity to gases.
- Purity requirements of electrodes.
- Reproducibility.

“Homemade” Electrochemistry

“Homemade” Electrochemistry reactors -

- Inconsistent distances between electrodes.
- This risks influencing the voltage & reaction success/efficiency.
- Hazard of electrodes touching in flammable solvent.

Historically…

Photochemistry, Flowchemistry, and Electrochemistry in the past were relatively niche areas of chemistry.

Whilst popular, growth in these areas has been hindered by:

- Technical limitations
- High barriers to entry
- Lack of established data

Technology - Photochemistry

- Improved, accessible LED technology
- Moving away from Hg lamps which emit a wide range of wavelengths.
- More selective reactions, less energy waste, and less risk from UV.
- Improved methods for batch across varied scales.

Technology – Flow Chemistry

Development of standard flow reactors for varied requirements, including solid-liquid / solid-liquid-gas reactions.

- More accessible in R&D
- PFRs (Plug Flow Reactors), CSTRs (Continuous Stirred Tank Reactors), PBRs (Packed Bed Reactors), BCRs (Bubble Column Reactors).

Flow Chemistry + Photochemistry

- Flow chemistry is optimal for scaling photochemistry.
- Modular / specialist reactors to accommodate high requirements or changing needs.

Technology

Flow Chemistry

- Automation – real-time monitoring and programmable control.
- Modular design – flexible reactor usage for optimising processes.
- Reporting – Greater accessibility to experimental data.

Technology

Electrochemistry

- Improvements in electrode mounting design for consistent reporting.
- Control of inert atmospheres, stirring and heating in parallel
- Potentiostats for cyclic voltammetry are more powerful and come with improved reporting/data processing.

www.asynt.com
enquiries@asynt.com
+44 (0)1638 781709

Impact on the Chemistry

- These new developments in chemistry equipment enable greater flexibility and control.
- By simplifying equipment, chemists can focus on the chemistry.
- Photo-, electro- and flow chemistry are more accessible and have clear methods for scaling up.