PALEUS

Aqueous Emulsion Polymerisation as a Platform

for Sustainable, High-Performance Process & Formulation Design.



PRESENTED BY

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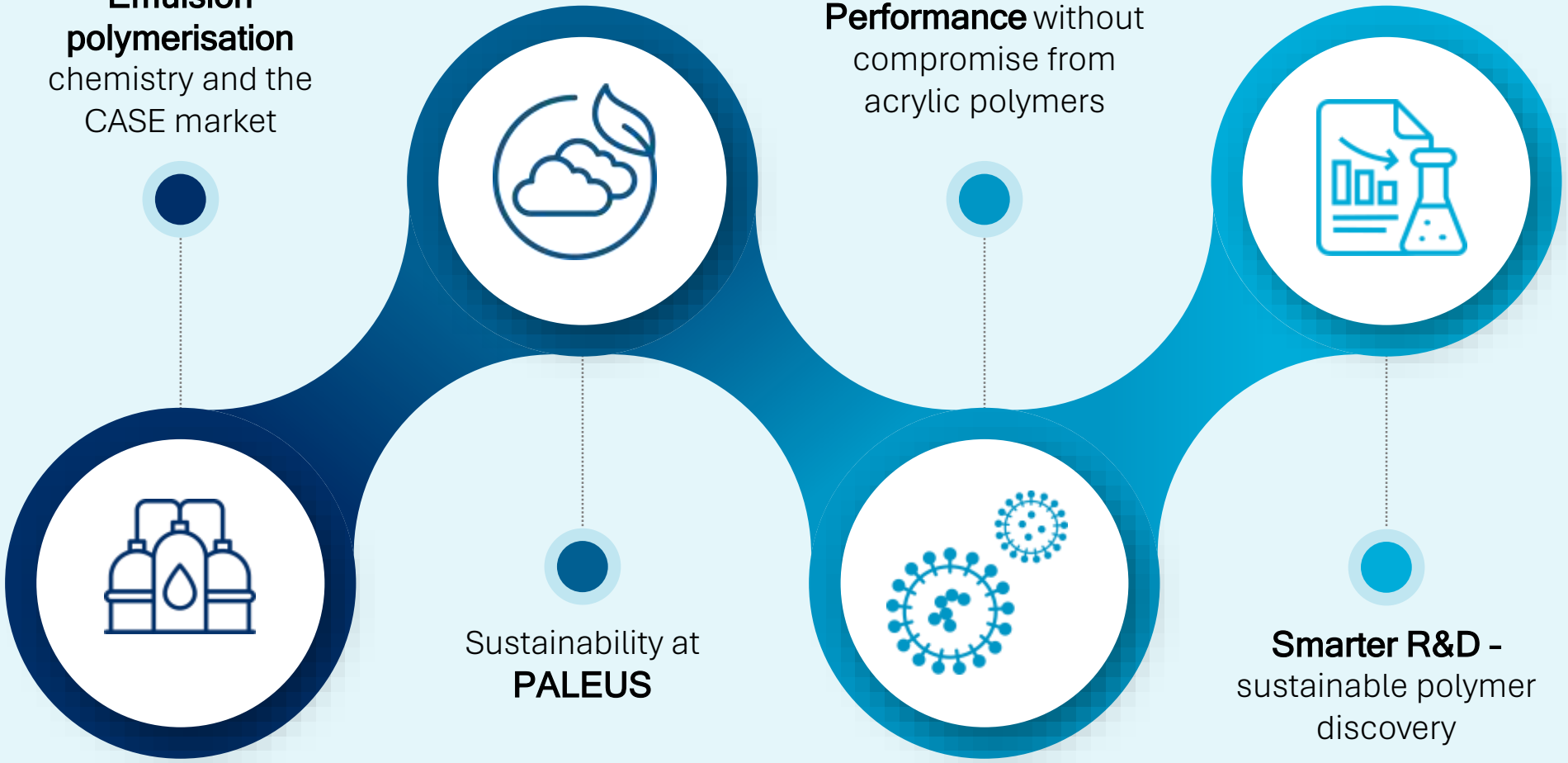
Overview

Emulsion polymerisation chemistry and the CASE market

Sustainability at **PALEUS**

Performance without compromise from acrylic polymers

Smarter R&D - sustainable polymer discovery



The World is **Changing**

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Environmental Regulation

Tightening VOC limits and REACH compliance are no longer optional, they're the baseline.



ESG-Driven Procurement

Buyers and investors are demanding carbon accountability throughout the supply chain.



Carbon Accountability

Life-cycle emissions are now a competitive differentiator, not just a reporting exercise.

These changes are not a trend

An example – **CASE Industry**

Market Drivers

- The global construction chemicals market is **~$65B** today
- The renewable energy transition took **20 years** to reach price parity with fossil fuels
- The market for sustainable materials is predicted to grow from $33.5B to $55.7B in 2034
- That's a CAGR of **7.2%**
- This outpaces the broader construction market **growth of 4.5%**

Strategic Shift

- The architects and sustainability consultants are writing embodied carbon requirements into specifications **today**
- Raw material choices are **locked in at the point of manufacture**
- The transition pathway from **solvent to water based** has already been made.
- **Biobased** is the next increment

Lever	Timeline to impact	Capital required	Infrastructure dependency
Operational energy (heat pumps)	10–30 years at scale	High	High (grid)
Renewable energy procurement	2–5 years	Medium	Medium (certificates)
Raw material substitution	1–4 years	Low	None

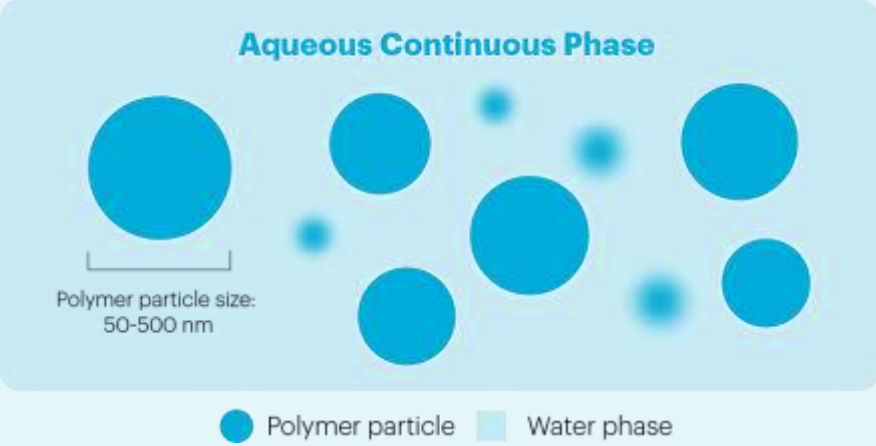
Sources: IEA Tracking Clean Energy Progress — Buildings; IPCC's Sixth Assessment Report (AR6)

Aqueous Emulsion Polymerisation

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What is it?

- Monomer droplets dispersed in water using surfactants
- Radical polymerisation occurs inside micelles / growing particles
- Product is a stable latex of polymer particles in water
- Particle size typically 50–500 nm



Key Benefits

Solvent
Water — abundant, non-toxic, non-flammable

VOC Emissions
Negligible — water evaporates harmlessly

Heat Management
Water's high heat capacity aids temperature control, safer exotherm

Solids Content
High solids (40–70%) achievable without viscosity penalty

Waste & Disposal
Minimal solvent waste; easier downstream processing

Regulatory Compliance
Low VOC — meets tightening EU/global environmental regulations



Lower carbon footprint

Safer for workers

Regulatory future-proof

Using emulsion polymerisation to upgrade **performance of materials**

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Water Resistance

Water based binders are inherently vulnerable to hydrolysis & moisture ingress

Progress

Crosslinking: carbodiimides, silanes & aziridines

Core-shell architecture with hydrophobic cores

Hydrophobic monomers (styrene, MMA, VeoVa™)



Durability & Adhesion

Matching solvent-borne toughness & substrate adhesion long-term

Progress

Tg optimisation via monomer composition

Adhesion promoters & primer-free coatings

Multi-functional crosslinkers for film integrity



QUV / Weathering

UV degradation, gloss & colour loss in exterior use

Progress

Acrylic monomers for UV stability

Compatibility with performance enhancing additives

QUV benchmarked vs. alkyd performance standards



End-Use Performance

Scrub resistance, open time & block resistance at full spec

Progress

MFFT optimisation & coalescent reduction

Structured particles to decouple Tg & hardness

AI/ML formulation tools to close performance gaps

The goal: waterborne systems that are green by design
AND match solvent-borne performance

The Aqueous Platform at PALEUS



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Who are **PALEUS**?

PALEUS specialise in aqueous polymerisation

Key capabilities

Glass Lined Reactor Plant | Acrylic Polymer Plant | Development and QC lab

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There are three parts to the **PALEUS Group** of companies

PALEUS Contract Chemicals
Confidential contract chemical manufacturing partner with 30+ years experience.

PALEUS Acrylics
Developer and producer of acrylic polymer solutions since 2004.

Majorchem
Supplier of specialist 'own branded' chemicals (predominantly demulsifiers) to the oil & gas processing industry.



UK Manufacturing plant
Pitman Rd, Denaby Main,
Doncaster DN12 4LJ

Waterborne is our core platform

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Aqueous Polymerisation

Waterborne technology is our primary production architecture – emulsion and solution polymerisation.



Performance by Design

We engineer polymer architecture at source. Performance is built into the polymer backbone.



No Compromise on Results

Durability, adhesion, and application integrity are maintained or exceeded vs incumbent solvent systems.

Why it matters



VOC

Significantly reduced emissions



Performance

No compromise



100%

Aqueous process — zero solvent waste

The PALEUS Portfolio:
One Philosophy, Many Applications

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Coatings

DTM solutions, architectural, industrial and protective coatings – **all water based.**

Adhesives

Pressure-sensitive and structural adhesive formulations with **strong** substrate adhesion.

Specialist Systems

Bespoke polymer architectures for technical applications requiring precise performance tuning.

The same design philosophy: high-performance waterborne chemistry engineered at source - underpins every product across the PALEUS acrylics portfolio.

Examples of **sustainability** at **PALEUS**



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Sustainability at **PALEUS**

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Water Usage
- Minimising consumption
- Promoting reuse

Waste
- Designing processes for minimal material loss

Toxicity
- Selecting safer chemicals
- Reducing hazardous by-products

Carbon footprint
- Reduce emissions across sourcing, synthesis and processing
- 100% green electricity use corresponds to -43.7 tCO2eq per year

Energy efficiency
- Optimising conditions to lower energy demand without compromising performance

Products
- Integration of biobased monomers into our polymer backbone
- Create multifunctional binders to reduce need for excess raw material numbers



Acrylics – closing the performance gap

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Evolution of waterborne acrylics

Traditional
Pre – 2000

- Standard petrochemical monomers
- Alkyd and PU dominate
- Fluoro-modified acrylics narrow weathering gap

First-Gen Advances
2000 - 2010

- Crosslinking chemistry (carbodiimides, silanes)
- Different particle morphologies accessible - CRP
- Silicone modified acrylics achieve weathering performance of pure silicone topcoats

Closing the Gap
2010 - 2020

- UV-curable acrylics outperform silicone
- High-Tg formulations and crosslinkers achieve parity with epoxy and phenolic systems

Current State-of-the-Art
2020–Present

- More specialty monomers available on market e.g. VeoVa
- Bio-acrylates (2-octyl, itaconic) approaching parity

Performance comparison - current generation

	Water based acrylic	2K Polyurethane	Solvent based acrylic	SBR latex
Property	**Coating performance**			
Water resistance	✓	✓	✓	✗
UV resistance	✓	✓	✓	✗
Adhesion to substrate	✓	○	✓	○
Flexibility	✓	○	○	✓
Hardness	○	✓	○	✗
Chemical resistance	✓	✓	○	✗
Low VOC	✓	○	✗	✓

Waterbased **DTM coatings**

PALACRYL 7030:
Proof in Practice

PALACRYL 7030 is engineered to replace multi-coat solvent-based systems with a single waterborne solution without sacrificing any performance requirement.



Property	Solvent System	PALACRYL 7030
VOC Emissions	High	Low / Compliant
Coats Required	2–3 coats	Single coat
Adhesion to Metal	Strong	Strong
Corrosion Resistance	Good	Good
Weathering Durability	Good	Excellent

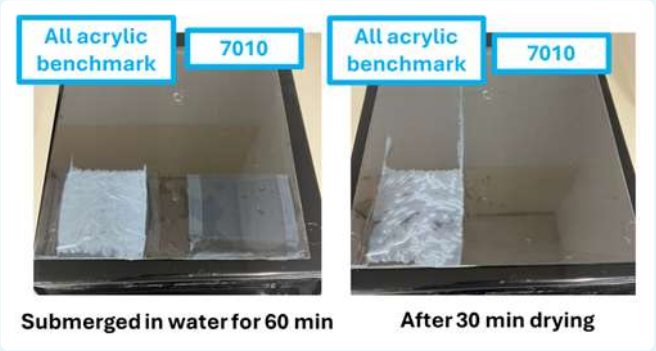
Design Philosophy

- One coat replaces three
- Zero compromise on corrosion protection
- Engineered for long-term weathering
- Same design logic across the entire PALEUS portfolio

Durability improvements – **water resistance**

PALACRYL 7010:
Proof in Practice

PALACRYL 7010 incorporates speciality monomers to enhance adhesion and water resistance.



Property	Commodity pure acrylic	PALACRYL 7010
Water whitening resistance	None	Good
Early water resistance	Poor	Good
Adhesion to Glass	Weak	Strong
Weathering Durability	Good	Excellent

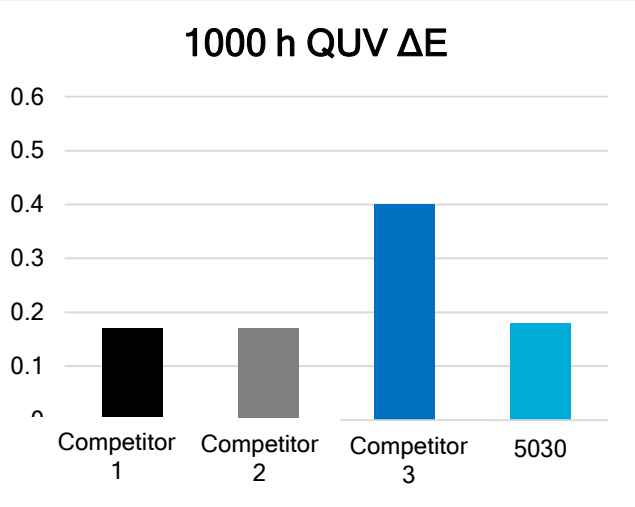
Design Philosophy

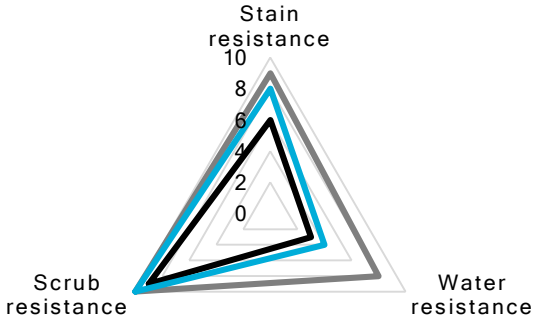
- Polymer backbone provides functionality
- Speciality monomers and architecture enhances water resistance
- Engineered for adhesion and water resistance

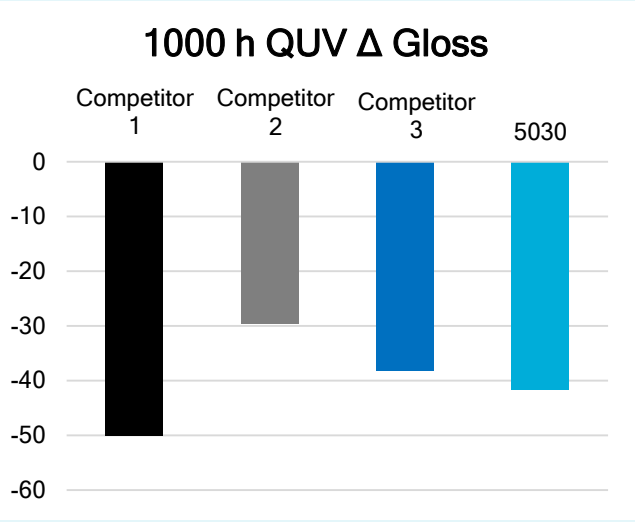
Durability improvements – **weathering resistance**

PALACRYL 5030:
Proof in Practice

PALACRYL 5030 is a high performance pure acrylic multipurpose paint binder.







Design Philosophy

- Designed to perform in challenging environments
- Compatible with a wide range of additives
- Engineered for long-term weathering
- Matches high performance competitor grades

Incorporating **bio-renewable content**

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Castor Oil
Renewable feedstock

2-Octyl Acrylate
BASF biobased
73% 14C-traceable

Acrylic Polymer
Up to 67%
bio-renewable content

End Product
Performance
unchanged

Property	PALATAC P4920A	PALATAC ECO P4920B
Biobased content	0%	67%
Loop Tack (N)	13	14.5
180° Peel (24h) (N/25 mm)	8	7.0
Static shear (min)	20	26.2

Design Philosophy

- 1:1 drop in of ^{14}C traceable biobased monomer 2-OA
- PSA tack and peel strength maintained or improved
- Incorporation of biobased content does not affect performance

Approaches to **increase bio-content**

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Technical Pathways:
Three Routes to Higher Biocontent

Drop straight in
Biobased monomers that replace fossil inputs 1:1, no reformulation

Step sideways
Chemically similar alternatives that match performance with a greener profile

Start fresh
new binder architectures designed from the ground up for high biobased content

Market Reality

Customers won't pay a premium for the same product in a green wrapper



Value Creation

New biocontent materials must earn their place through **better performance**

Up to 80% of a product's environmental impact is locked in at the R&D stage

The goal isn't substitution.
It's using **bio-based innovation** to enable solutions that weren't previously possible.

R&D is a long cycle process, involving **extensive testing**, iteration and validation

Researching sustainably – an example in practice

AI-driven discovery

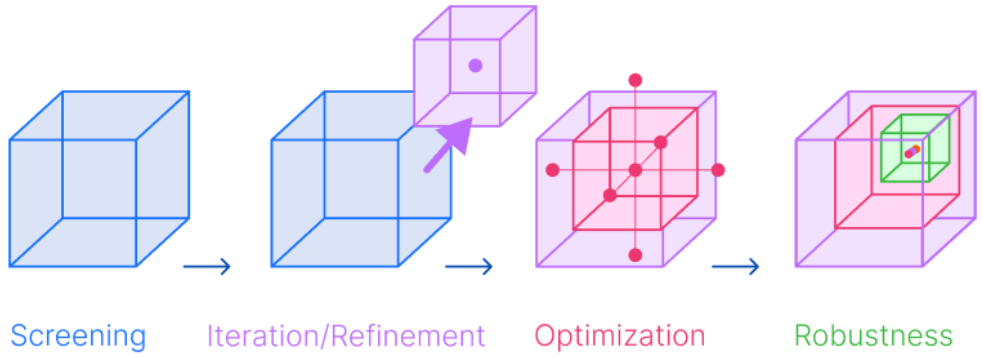
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Use of **DOE in R&D**

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A Smarter Approach

- Chemical reactions depend on many interacting parameters
- DOE is a structured approach to optimising processes through planned experiments
- Uses statistics to study multiple variables simultaneously
- Replaces trial-and-error and exhaustive testing
- Focuses experiments on the most influential factors



AI-Driven DOE Optimisation

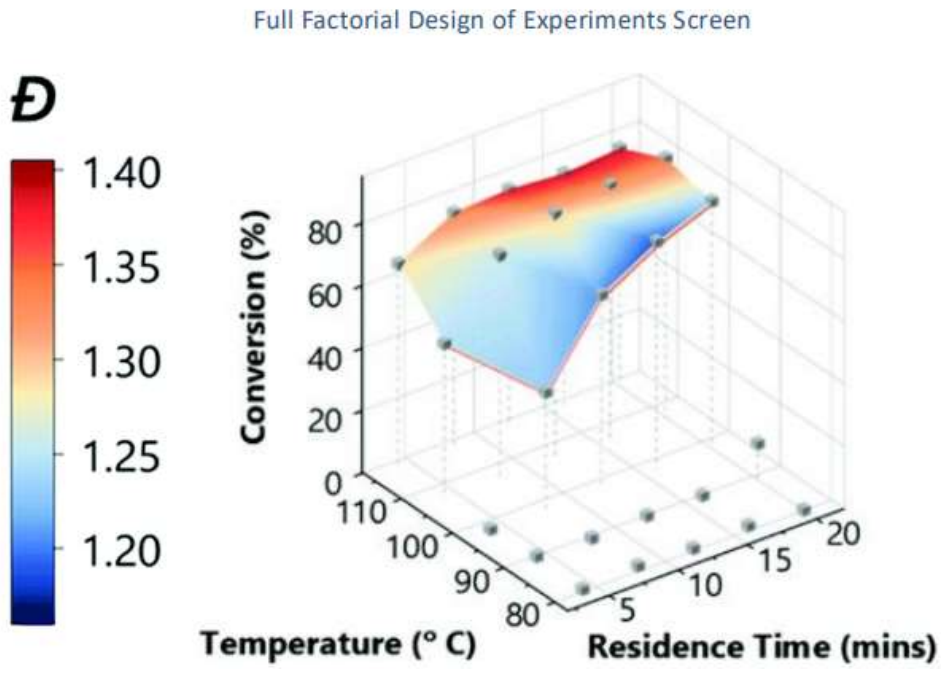
- Navigates multidimensional formulation spaces
- Accelerates discovery cycles dramatically
- Unlocks previously impractical performance combinations

Data tools and **machine learning**

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A Smarter Approach

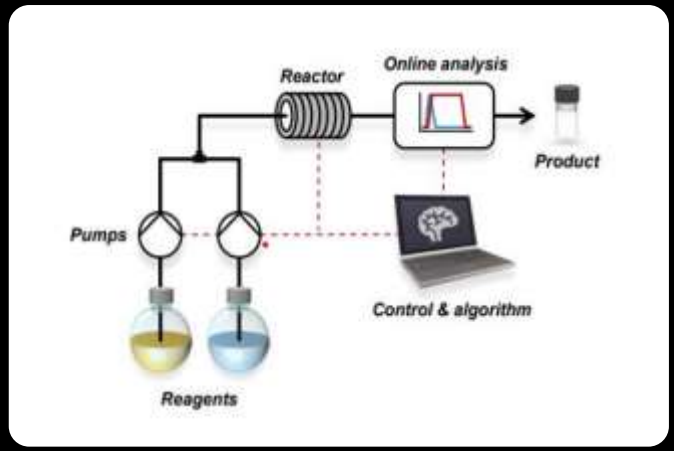
- Classical DOE explores the space using **fixed** experimental design
- AI-enabled DOE uses **adaptive** experimentation
- This shifts the goal from covering the space, to **learning the system**



Optimisation as an Iterative Loop

AI reframes reaction optimisation as a loop:

1. Run an initial small DOE
2. Train a model on the results
3. Use the model to propose new conditions
4. Experiment, then retrain

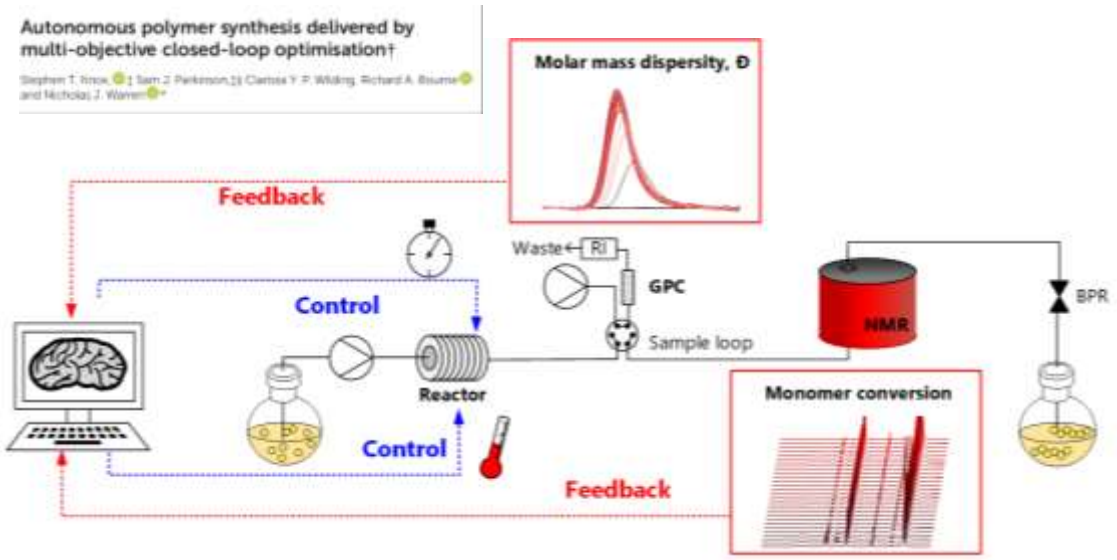


Each iteration concentrates experiments where they matter most. Continuous flow reactors allow this process to happen.

Continous **flow reactors**

Moving beyond trial-and-error

- First-ever closed-loop, user-free multi-objective optimisation in polymer synthesis
- Balancing competing targets rather than collapsing them into a single metric
- Real-time AI decision-making directly coupled to synthesis and analytics, allowing the experiment to design and refine itself



Why it Matters

- Minimal prior knowledge required — only boundary conditions (temperature range, residence time) needed as inputs
- Effectively opens the polymer lab to **24/7 autonomous productivity**
- Generalisable to other polymerisation chemistries, additional input variables, and more complex objective sets
- Lays the foundation for **AI-driven discovery** of next-generation advanced polymer materials

Automated Flow Reactors for Self-Optimisation of Polymerisation Reactions

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Key Objectives

Build the Platform

Construct a flow reactor to systematically explore key reaction parameters in RAFT and emulsion polymerisation

Implement Emulsion Polymerisation

Translate industrially relevant emulsion formulations into the automated continuous-flow environment

Multi-Objective Optimisation

Autonomously balance competing formulation goals: conversion, dispersity, particle size, using AI-driven algorithms

Build a Reaction Database

Generate rich datasets of optimised conditions to enable faster, more efficient routes to commercial scale-up

PhD Research Partnership

University of Sheffield

Chemistry & Materials Engineering Department

HENRY ROYCE INSTITUTE

CDT-Funded Doctoral Programme

PALEUS

Supervisors

Prof N. J. Warren and Prof S. P. Armes

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Future-Ready
Chemistry Starts Now

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stand E124
Request samples
Start a conversation

- Waterborne is not the compromise — **it is the platform**
- The **PALEUS** portfolio: proven, today
- Bio-renewable content up to 67%, with **no performance sacrifice**
- **AI + flow chemistry:** the R&D model built for complexity



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