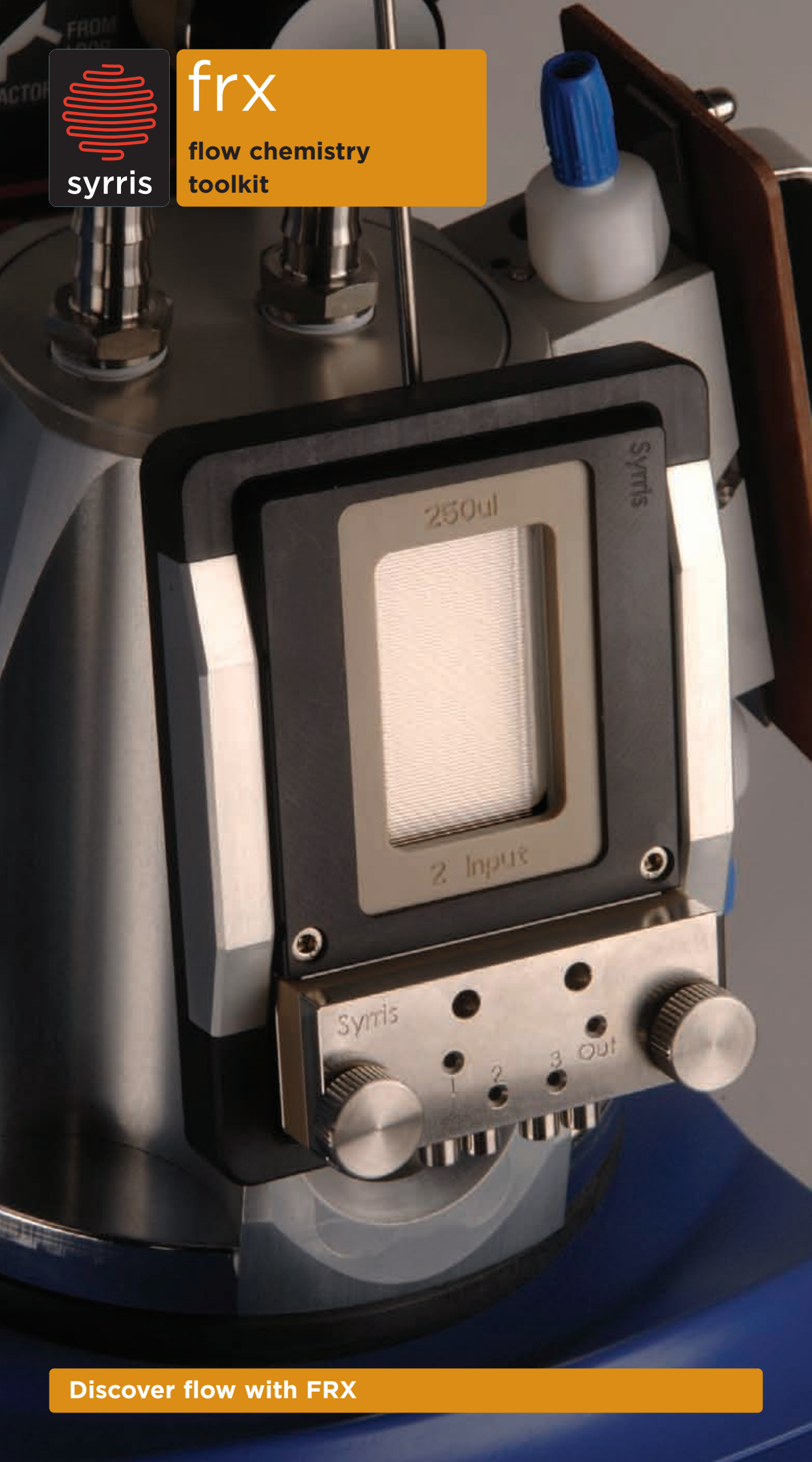




frx

flow chemistry
toolkit



Discover flow with FRX

Benefits and applications

Flow chemistry provides the following benefits over batch chemistry:

- Safer, cleaner chemistry via greater control of temperatures, reaction times, stoichiometry and mixing
- Increased reaction rates accessible through superheating of reagents
- Wide range of production rates on same apparatus
- Easy to visualise processes
- Online automated aqueous work-up

FRX has the following applications in discovery and process development:

- Reaction development
- Reaction optimisation
- Transfer of batch experiments to flow
- Preparative synthesis up to kg overnight
- Automated work-up
- Flow process design



FRX offers many advantages over other flow chemistry systems:

- Easier to use and faster to set up
- Lower cost
- More chemically resistant
- Greater functionality

Above: Reaction rates can be increased 100 fold (vs. atmospheric reflux) by superheating whilst using the back pressure regulator (BPR).

Left: The FRX tube reactors allow scale up synthesis of grammes to kilogrammes overnight.

What is FRX?

The FRX system from Syrris makes flow chemistry cost effective, easy to use, understandable and affordable. FRX is made up of a number of modules that can be connected together to form simple yet powerful flow chemistry systems.

FRX benefits

- **Faster reactions:** Increase reaction rates over 100 fold by superheating reactions significantly above reflux e.g. dichloromethane to 100°C, acetonitrile to 150°C and water to 170°C.
- **Cleaner reactions:** Reduced impurities via excellent, reproducible reaction control and optional use of solid phase reagents/catalysts/scavengers.
- **Inline aqueous work-up:** The Flow Liquid Liquid Extraction Module (FLLEX) enables two immiscible phases to be mixed and separated in flow, immediately following the reaction.
- **Safer reactions:** Only small amounts of material react at any time, minimising exotherms and the quantity of any hazardous intermediates.
- **Rapid development:** Reaction time, temperature and equivalents can be rapidly varied using mg of substrate.
- **Scale-up:** Production rates up to kg overnight.
- **Wide temperature range:** Heat reactions up to 200°C or cool down to -20°C.
- **Chemically resistant:** Glass and PTFE reactors allow a wide range of chemistry.
- **Compact size:** FRX systems fit easily into standard fume cupboards.

FRX systems

All the FRX systems are intuitive and easy to use, without the need for tools. The configuration of a system can be changed in seconds to meet the needs of different reactions.

FRX100

This is the smallest system allowing users to conduct simple, solution phase flow chemistry experiments on g to kg scales.

FRX200

This is a more flexible system enabling mg - kg synthesis. Reaction optimisation and synthesis are possible using a range of different reactors, a reagent module to allow flow injections and solid phase reagents.

FRX300

This system offers the flexibility of FRX200 plus online aqueous work-up with Flow Liquid Liquid EXtraction (FLLEX) technology.

FRX400

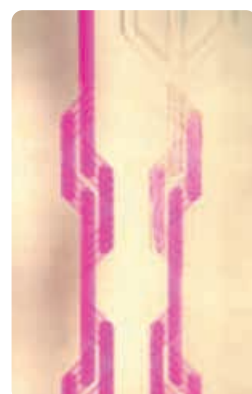
This a complete flow reaction system giving users the widest range of scale and reaction sophistication including FLLEX and a chiller block allowing reactions down to -20°C.



Above: Glass microreactors offer excellent control of mixing and reaction temperature with high chemical resistance.

Left: The FRX micromixer offers total mixing in less than 4 milliseconds.

Far left: The FRX FLLEX (Flow Liquid Liquid EXtraction) module allows inline aqueous work up.



The FRX system

Pump - Precise control of individual reagent flow rates using high performance pumps

Reagent injection - Manual addition of reagents through sample loops and valves to give fast change over between reagents

Micro reactors - Glass microreactors ("chips") in a range of sizes for small volume preparation (mg to g) and optimisation

Tube reactors - High volume reactors made of chemically resistant PTFE for large scale preparation (g to kg)

Column reactors - A reactor that allows solid phase reagents to be used inline

Volcano - Allows both microreactors and column reactors to be mounted on standard hotplates

Micromixer - A chip reactor designed specifically for rapid mixing in <4ms

FLLEX - Automated flow liquid-liquid extraction for work-up of products

Pressurisation - Back pressure regulation to allow superheating of solvents/reagents

Sample collection - Manually advanced carousel for collection of reaction products



The FRX pumps
These allow pumping rates from 10ul to 10ml per minute. A simple user interface makes flow rate selection easy.



The tube reactor
For scale up of reactions, the tube reactor, manufactured from chemically resistant PTFE (wettted parts) enables synthesis of up to a kg overnight.

The volcano
Glass microreactors for solution phase chemistry or column reactors for solid phase chemistry can be heated from any standard hot plate or chilled using a cooling insert in combination with any cooling circulator.



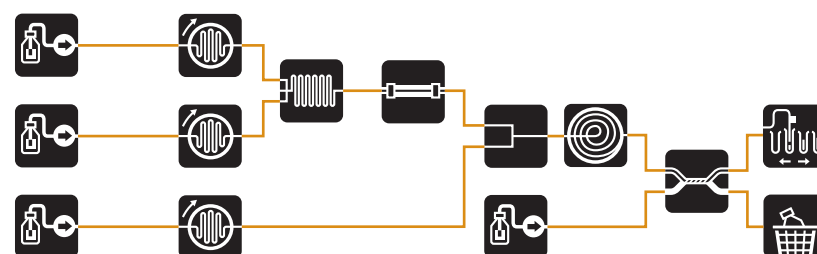
The pressurisation module
This gives the FRX system the ability to work at substantial over-pressure (up to 10 bar) thus allowing superheating and enhanced rate effects.



The collection carousel
This provides a flexible and convenient way of collecting fractions from an FRX process. A range of volumes can be collected into a variety of different vial sizes.

FRX 100
This is an entry level system designed to give users an introduction to flow chemistry with the ability to produce relatively large amounts of material.

The FRX400 system



This system has the ability to conduct reactions under superheated or sub-ambient conditions which together with tube, micro and column reactors allows multi-step synthesis and automated workup to be conducted quickly and easily.

FRX systems	FRX100	FRX200	FRX300	FX400
Pump module	2	2	3	4
Reagent injection module	○	●	●	●
Volcano	○	●	●	●
Hotplate	●	●	●	2
Cooling insert	○	○	○	●
Microreactor chip	○	●	●	3
Chip header	○	●	●	●
Column reactor	○	4	4	4
Tube reactor	●	●	●	2
Pressurisation module	●	●	●	●
Flow liquid-liquid extraction (FLLEX)	○	○	●	●
Collection carousel	●	●	●	●
Tubing pack	●	●	●	●
Flow starter pack	●	●	●	●
Micromixer	○	○	○	○

Standard ● Option ○

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