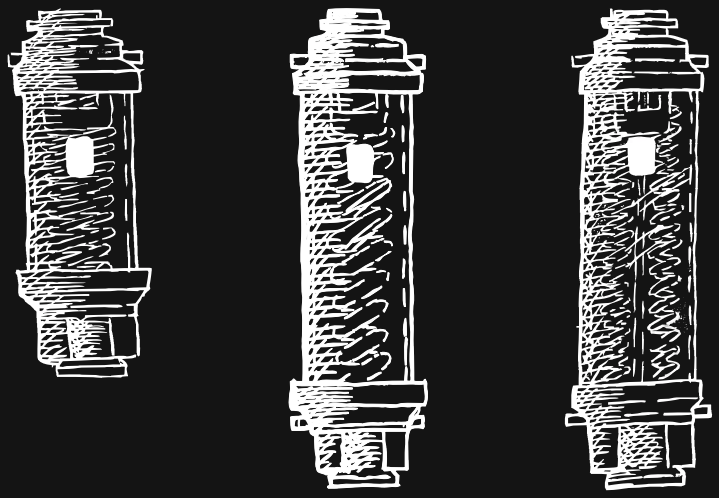
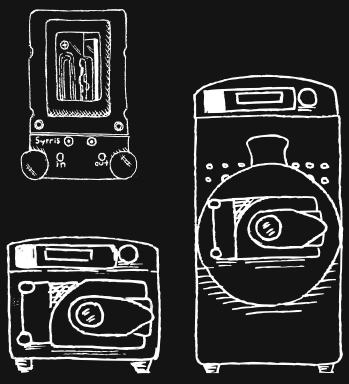


SYRRIS



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Syrris flow chemistry

Flow chemistry is a fast growing and exciting technology providing numerous benefits to chemists over traditional batch techniques. Chemical reactions can be faster, cleaner, more selective and reproducible.

A big advantage of flow chemistry is that scale up is more seamless due to maintaining excellent mixing and heat transfer. In addition, many chemical processes may proceed which are just not possible by other techniques.

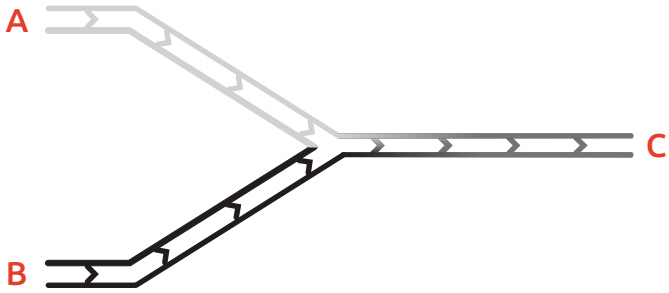
Syrris provides flexible, modular systems designed for R&D laboratories through to robust platforms designed for chemical process scale up.

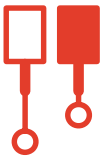
Syrris has been at the forefront of the growth of the flow chemistry market. As the world's longest established provider, Syrris has won prestigious R&D awards for their flow chemistry systems and support leading industrial and academic chemists and engineers around the globe.

About flow chemistry

Flow chemistry, sometimes referred to as plug flow microchemistry or continuous flow chemistry, is the process of performing chemical reactions in a continuous tube or pipe. Reagents are pumped together at a mixing junction and the flow continues down a temperature controlled tube or pipe.

The ratio of the reactants are controlled by their concentrations and relative flow rates. The rapid mixing and large surface area to volume ratio provides excellent reproducibility and control of a chemical process.



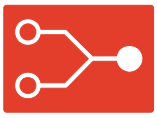


Syringe Pump

Pumps are potentially the most important part of a flow chemistry system. Without confidence in pumping accuracy and performance many of the advantages of flow chemistry are lost.

Pressure

The ability to apply pressure to a flow chemistry reaction is a major benefit of using the technique. Pressure allows superheating of the reaction mixture which can dramatically increase reaction time. Applying pressure can also control reactions that involve gas or where gas is added as a reactant.



Microreactor

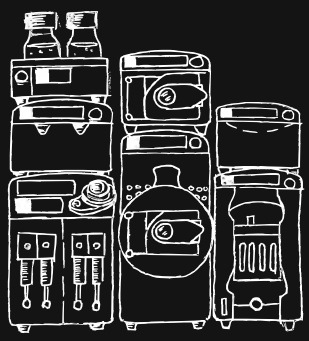
Flow chemistry reactors need to be as versatile as possible to cover the greatest range of reaction conditions. Reactors should be flexible in volume to allow a large range of residence times, provide excellent mixing/heat transfer and offer good visibility where possible. Reactors also need the ability to perform different types of homo/heterogeneous chemistry.

Product Collector

The unique properties of flow chemistry allow as much material as required to be collected without the restriction of reactor size. Small amounts can be collected for reaction optimization and larger quantities for scale up applications.

The Syrris flow family

The Syrris flow chemistry product range spans scales from the lab through the pilot plant to manufacturing.



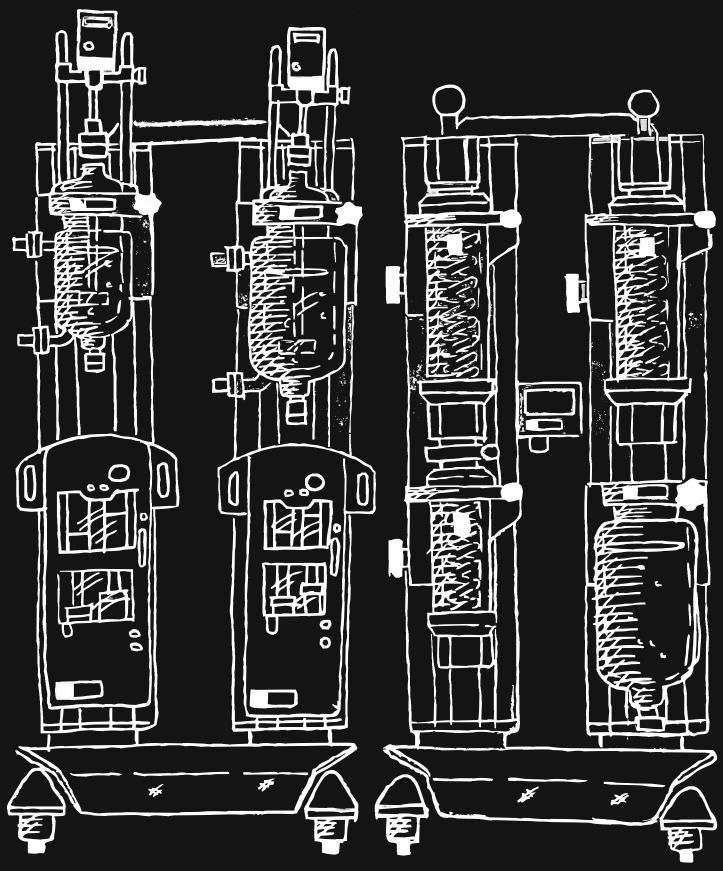
7 Asia

Modular, lab-scale flow chemistry systems.

1 µL/min to 10 mL/min flow rate*

-100 to +250 °C temperature

Up to 20 bar pressure



14 Titan

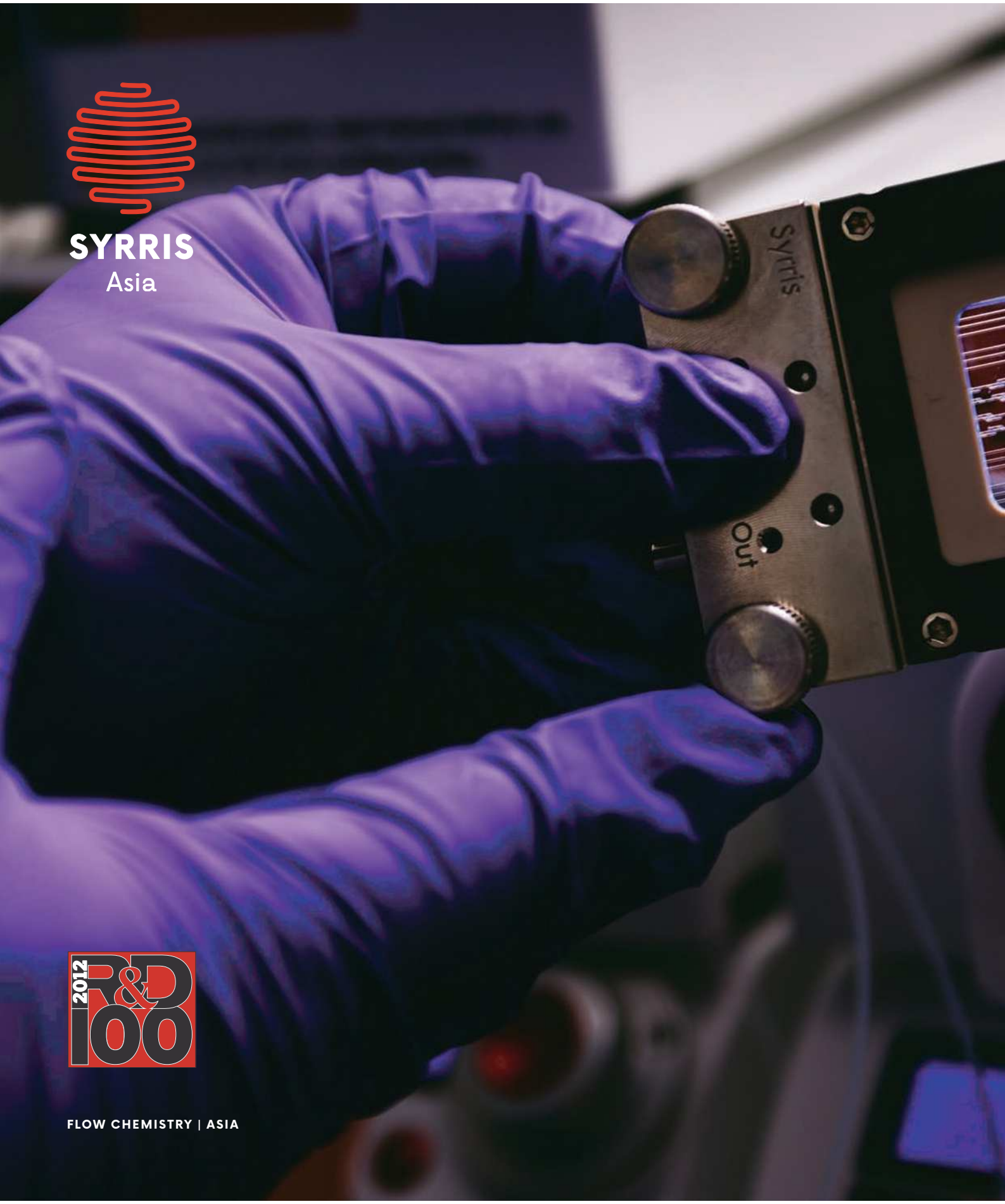
Large scale, modular continuous flow systems.

1 to 250 mL/min flow rate*

-40 to +250 °C temperature

Up to 20 bar pressure

*Per pump channel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FLOW CHEMISTRY | ASIA

Asia

Asia is a revolutionary range of advanced flow chemistry products. It has been designed by chemists for chemists to enable the widest variety of chemical reactions and ultimate ease of use.

Asia offers a variety of flow chemistry modules and systems in either entry level or advanced configurations for both beginners with modest budgets and experts who demand the utmost functionality.

The modular nature allows you to be flexible with your application and adapt the system configuration to suit the needs of your chemical process. With other systems suitable for entry level and teaching applications, the Asia system is the ideal choice for R&D laboratory chemists.

Winner of the R&D 100 award which celebrates innovative technology and is a benchmark of excellence.

Benefits

Asia is unique. It can be configured specifically to your chemistry making the system a vital asset in any R&D laboratory.

- Perform a wider range of chemistries.
- Flexible to meet chemists' needs (and budgets).
- Integration of synthesis, work-up and analysis.
- Safer and cleaner reactions.
- More reactions in less time.
- Maximum chemical resistance.
- Robust and easy to use.

1 Automated introduction of reagents for complete walk-away synthesis.
2 Pressurized inputs allows air sensitive chemistry and enables smooth flow.
3 Inject small quantities of reagents into flowing stream using the Reagent Injector.
4 Microreactor control from -15 to +150 °C.
5 Input variable back pressure post reaction up to 20 bar.
6 Extra smooth flow rates from 1 µL/min to 10 mL/min per pump channel.
7 Cool reactions to -100 °C (microreactors) or -70 °C (tube reactors).
8 Heat reactions from ambient to +250 °C.
9 Enable on-line reaction analysis using LCMS, HPLC or UPLC.
10 Connect all modules to the Automator for complete control using PC software.

1 µL/min to 10 mL/min flow rate per pump channel

-100 to +250 °C temperature

Up to 20 bar pressure

"At Syrris, we have a very simple philosophy—our products are designed for chemists like you and the way you work."

Mark Gilligan, CEO

2 3 4 5 7 8 9 10

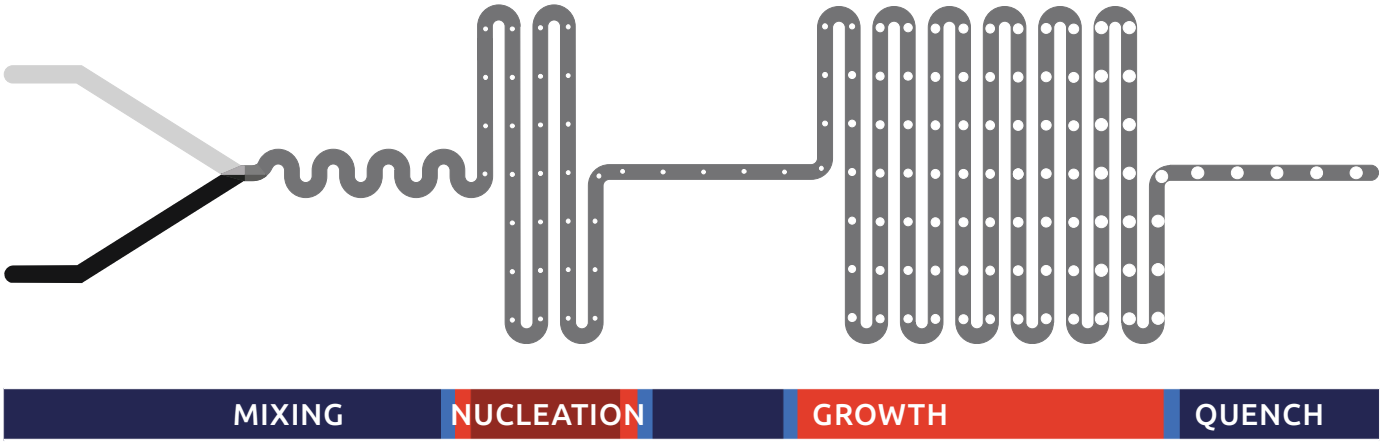
Asia systems

Asia is a modular system. All the Asia modules can be supplied separately or can be configured to suit the needs of your chemistry. An example of some pre-configured systems are shown below. Speak to one of our flow chemistry team to discuss the system you desire.

- Starter system
- Scale-up system
- Nanoparticle system
- Electrochemistry system
- Discovery chemistry system
- Premium system

An interview with Dr. Tom Jellicoe

EPSRC CDT in Nanoscience and Nanotechnology (NanoDTC)
University of Cambridge

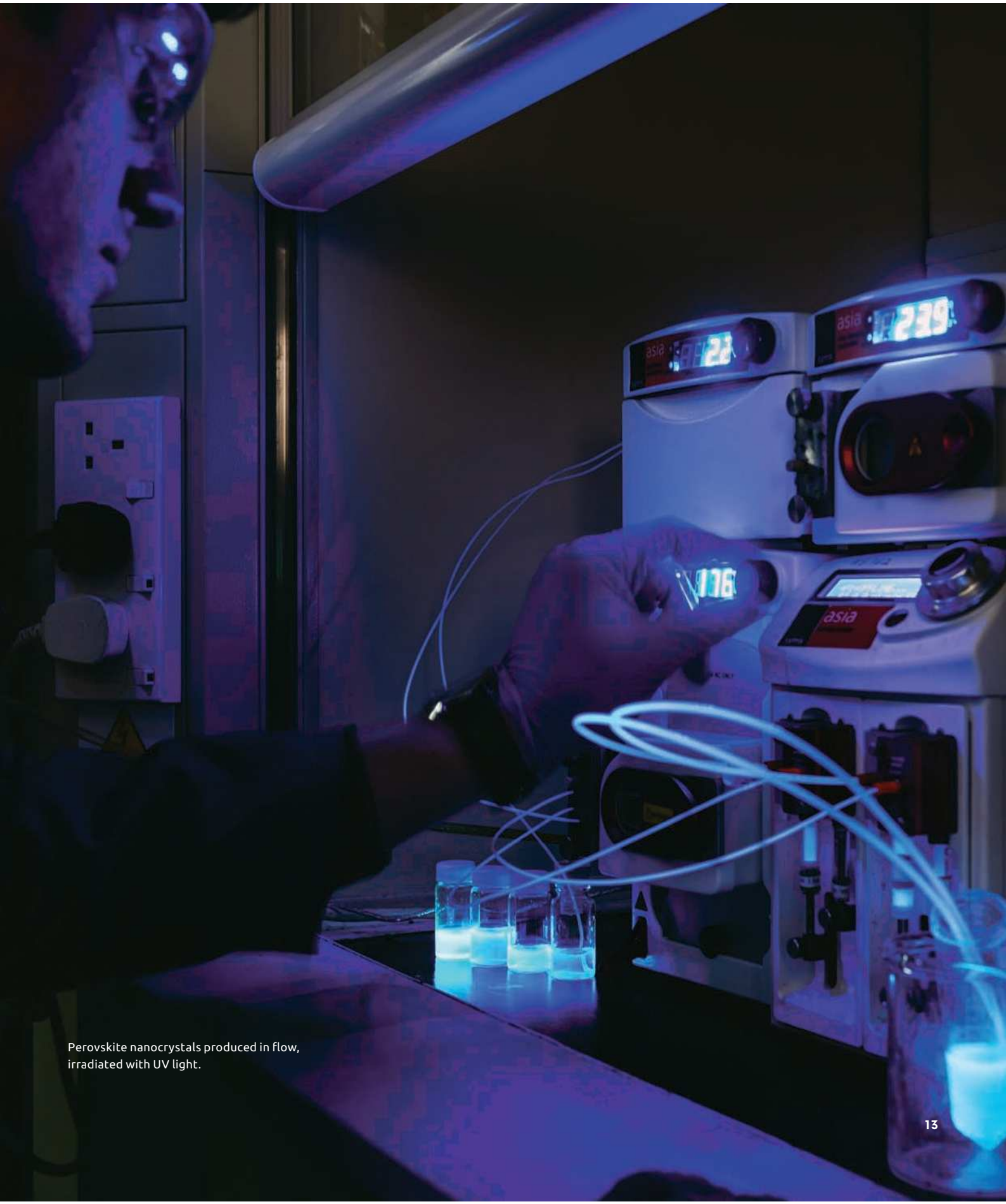


"The growth of quantum dots is susceptible to minute changes in reaction conditions, the unique control that flow chemistry permits gave me precise and repeatable quantum dot growth.

Many nanomaterials exhibit remarkable size-dependent properties which vary profoundly when the dimensions of the particle are varied on the nanometre scale. As such, it is necessary to ensure, as much as possible, that all nanoparticles within a sample are the same size (monodisperse) to maximize usefulness in applications.

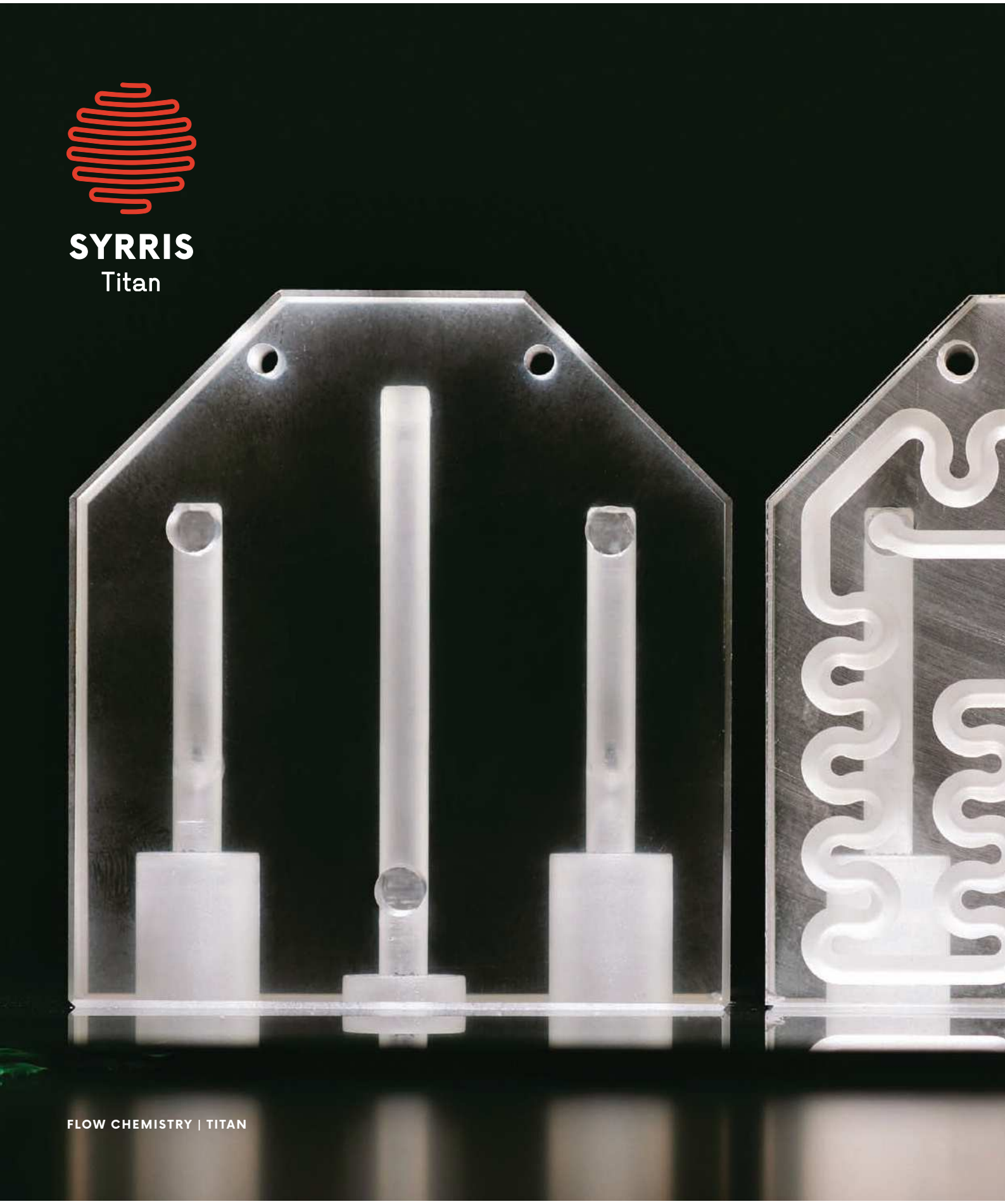
In the case of perovskite nanocrystals I was able to control the monodispersity with great precision and repeatability. Owing to the great deal of control of the reaction conditions Asia provided, all particles had similar growth history."

Tom Jellicoe is a quantum dot specialist concerned with development and production of nanoparticles. Tom holds a first class Masters in Chemistry with Nanotechnology from the University of Liverpool and a PhD in Physics (Optoelectronics) from the University of Cambridge. His doctoral research concerned the development of quantum dots for next generation solar cells and LEDs. Tom continued this research as a post-doctoral Research Associate in the NanoDTC group with Prof. Sir Richard Friend, Prof. Neil Greenham and Dr. Akshay Rao. He has experience in optimization of quantum dot syntheses, development of novel nanoparticle materials and commercialization of quantum dot research. Tom has won a number of prizes for research including the Zing nanocrystals prize in 2013 and the Royal Society of Chemistry, Chemistry World student prize in 2015.



Perovskite nanocrystals produced in flow, irradiated with UV light.

SYRRIS
Titan



FLOW CHEMISTRY | TITAN

Titan

Titan is a revolutionary continuous chemical processing system that enables seamless scale-up from kilo lab through to pilot plant and manufacturing.

Titan provides a complete solution for developing and scaling your continuous flow processes. It is designed to be assembled into a large range of different configurations in a short time period, requiring minimal tooling. The array of modules available are completely interoperable and can be set up to work with your application without the need to engineer parts and connections.

Syrris' award winning R&D team have utilized the expertise in microfluidics and glass fabrication with great design to enable a series of reactors capable of working with ultra-fast to slow reaction times.

Benefits

Titan is revolutionary—the only complete system to address the scale-up of continuous processes. Titan's development has been built on Syrris' many years of experience of the flow chemistry market.

- Complete turn-key system for development and scale-up.
- Reliable and robust, designed for long term use in manufacturing environments.
- Highly flexible and modular.
- High performance and ideally suited for high mass transfer and heat transfer processes.
- Scalable by adding or removing modules to achieve the desired output of the process.
- Extremely high chemical resistance.
- Easy to use and assemble with minimal tools.

> "Our vision has been to revolutionize flow chemistry and offer complete continuous processing solutions from lab scale through to manufacture. The future of continuous flow scale-up is finally here with the release of Titan."
>
> Dr. Omar Jina, CCO

1 Temperature controlled Reagent Stores.
2 Syringe pump with smooth flow rates from 1 to 250 mL/min.
3 Pre-Heat Exchange Reactor to ensure reagents reach reaction temperature.
4 Rigid Intermodule Connector for seamless connection of all reactors.
5 Fast Mixing Injector (FMI) for high mass transfer.
6 Residence Time Unit (RTU).
7 Post reaction back pressure regulator.
8 Product Collection up to 50 L.

1 to 250 mL/min flow rate per pump channel

-40 to +250 °C temperature

Up to 20 bar pressure


1
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Titan systems

Regardless of scale, each Titan system is comprised of the same modules. Modularity is at the heart of the design of Titan. This means that if you change your chemistry, scale or process, Titan can be changed to suit.

The key modules of the system (pump, reactor, stores and collection vessels) can be combined in series and in increasing levels of complexity to create any system from benchtop lab-scale through to full manufacturing.

Syrris' design philosophy of ease of use has been considered throughout the development of Titan. All modules have been developed to require minimal use of tools and removal and adjustment of module positions can be done in minutes.

- Lab scale system
- Pilot plant system
- Manufacturing scale system

Syringe Pump

The Titan Syringe Pump is the first pump on the market developed specifically for large scale continuous processing. It has been designed for safe and reliable scale-up and offers ultra-smooth fluid flow for lab, pilot plant and production scale applications.

Powerful drive motors and innovative valve design have been combined with software control to deliver flow rates from 1 to 250 mL/min up to 20 bar with solutions of viscosities up to 1000 cP.

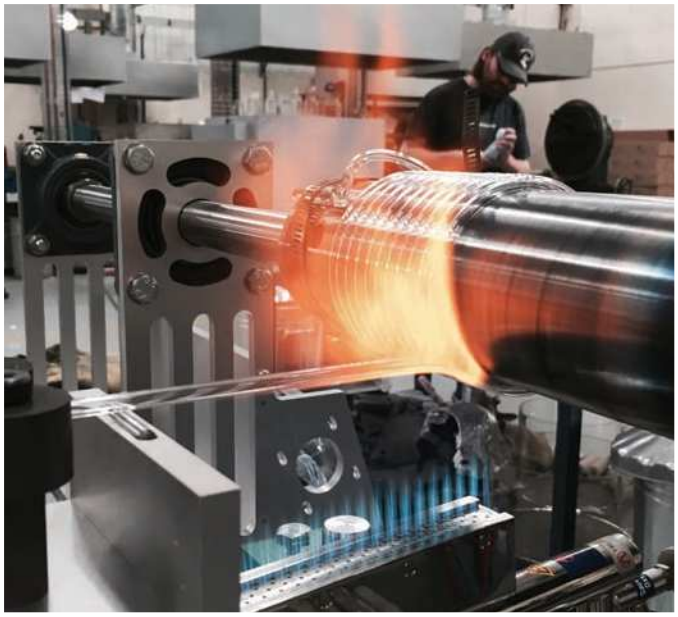
The novel syringe cassette is designed for seamless interchange. It also allows seals to be replaced with minimal use of tools. Pressure sensors, safety door, lock-out tags and connectivity to 3rd party E-stop hardware ensures a safe working environment.

Reactors

Titan features various reactor modules that can be quickly connected together to create single- or multi-step and multi-temperature zone reactors.

The different types of reactor include:

- Pre-Reaction Heat Exchanger to heat or cool reagents prior to the reaction.
- Fast Mixing Injector (FMI) has been designed for fast reactions requiring extremely high mass transfer and heat transfer.
- Residence Time Unit (RTU) offers excellent temperature control for the desired residence time of the reaction. Reactor volumes of 64 and 250 mL with the ability to connect multiple RTU's to achieve the desired reactor volume to suit the process.
- Post-Reaction Heat Exchanger to heat or cool the reaction back to near ambient temperature.



Rigid Intermodule Connector

A key component of the Titan Reactors is the Rigid Intermodule Connector (RIC). These come in a range of designs to allow straight-forward reconfiguration of an entire system. Designs range from Fast Mixing Injector RICs, which incorporate micromixer technology, to simple mixer RICs, straight-through RICs and Sampler/Injector RICs. These components feature patent-pending seals and temperature monitoring.

Titan Framework and Reagent Stores

Titan has numerous accessories including Framework, Reagent Stores and Product Collectors. The framework is designed to enable easy mounting of pumps, reactors, feed vessels and all other modules. The frame is modular and several frames can be quickly clipped together to allow seamless scaling of your Titan system. The frame is designed to fit into a walk-in fumehood and has integrated electrical and communications cables.

Temperature controlled Reagent Stores and Product Collectors from 1 to 50 L can be stirred prior to introduction to the continuous process.

Meet the team

Andrew Mansfield
Product Manager
Andrew has many years of experience as a Research Chemist for Pfizer in the pharmaceutical industry gaining expert knowledge in flow chemistry and medicinal chemistry. Andrew is the Syrris product manager for lab scale flow chemistry systems and is our in-house expert for flow chemistry applications.

Dr. Andrew Lovatt
CTO
After completing a PhD/Postdoc in materials/manufacturing engineering at the University of Cambridge, Andrew Lovatt entered technical consulting with Scientific Generics (now Sagentia). He joined Syrris in 2002 and now oversees all R&D activities including software, mechanical and electrical engineering and design.

Join an event

Join a workshop or demo the system
Syrris host an annual program of free chemistry workshops and training on a wide range of subjects, including flow chemistry. We have had fantastic feedback from previous delegates who work in a wide range of application areas. To register or enquire about upcoming chemistry workshops, complete our contact form or email workshop@syrris.com.