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TECHNICAL DATA SHEET

K10 REACTION SYSTEM

2026

REVOLUTIONISING ADVANCED MATERIALS DISCOVERY AND MANUFACTURE

WE PARTNER WITH MANUFACTURERS TO ENABLE SCALABLE PRODUCTION OF ADVANCED NANOMATERIALS

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K10

OVERVIEW

DESCRIPTION

The K10 reactor system extends the core innovations of the K1 into a pilot-scale platform capable of producing up to 10 kilograms of nanomaterials per day. Designed for organizations transitioning from R&D to pre-commercial and early manufacturing stages, the K10 delivers high-throughput production without compromising precision, safety, or material performance.

Built on AM's patented high-shear annular flow technology, the K10 enables continuous nanomaterial synthesis under mild operating conditions, eliminating the need for extreme temperatures and pressures. This approach ensures a safer operating environment while delivering exceptional control over particle size distribution, morphology, and batch-to-batch consistency at significantly higher throughputs.

The K10 maintains the same intelligent, data-driven architecture as the K1, incorporating built-in sensors to monitor reaction conditions, analyze process data, and automatically optimize operating parameters. This capability reduces development cycles and ensures consistent product quality as production volumes increase.

The K10 Start incorporates annular flow reactor technology with AI-driven optimization and automation.

Processes developed on the K1 can be transferred directly to the K10 with minimal reconfiguration or re-optimization, significantly reducing scale-up risk. The system also serves as a direct bridge to AM's K100 (100 kg/day) production platform, enabling a seamless and predictable path from laboratory innovation to commercial manufacturing.

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K10 SYSTEM MODELS & FEATURES

FEATURES	START	PRO
Dosing	Continuous Low Pulsation Pumping	• Continuous Low Pulsation Pumping • Automated Valves
Product Collection	None	None
Max Number of Reagents	2	4
Automation Level	• Single Batch Dispensing • Manual Cleaning & Loading	• Continuous Dispensing • Autonomous Reaction & Cleaning
Use Cases	Single Batch Synthesis	Multi Sample Synthesis
Sensors	Pressure	Pressure

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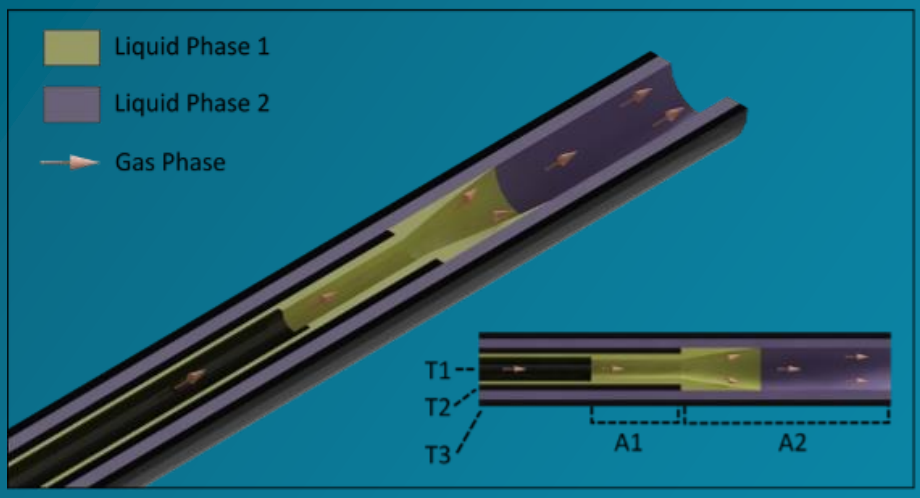
ANNULAR MICROREACTOR MODULE

REACTOR PRINCIPLES

The K10 reactor operates on the principle of precise shear rate control at magnitudes as high as 10^6 s^{-1}, the annular flow reactor enables precise manipulation of mixing and nanoparticle formation dynamics This results in the precision synthesis of targeted particle size, crystallinity, morphology, and other critical characteristics of nanomaterials.

A high shear rate is achieved by accessing a fluid dynamic regime known as "multiphase annular flow". In this regime, liquids and gases flow through a pipe with high differences in relative velocity. A high velocity gas forces liquids to the walls of the pipe, leaving a gaseous annular core. In the thin film that the liquids occupy (10 – 200 µm), there is a very high yet uniform distribution of shear rates. Chaotic mixing also occurs at the gas and liquid interface due to a phenomenon known as "Kelvin-Helmholtz instabilities".

An example schematic of a two-reagent flow is given below, where three tubes (T1, T2, T3) create two annular flow zones (A1, A2). In section A1, air flow through T1 forces Liquid Phase 1 into a thin film at the inner walls of T2. In A2, the thin film of Liquid Phase 1 from A1 is then contacted with a thin film of Liquid Phase 2. In T3, mixing and reaction occur.



Schematic Cross Section of Annular Flow Reactor. Not to scale.

LABEL	LEGEND
A1	Annular Region 1
A2	Annular Region 2
T1	Tube 1 (Gas)
T2	Tube 2 (Liquid 1)
T3	Tube 3 (Liquid 1 + Liquid 2 Mixing Zone)

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REACTOR SPECIFICATIONS

The K10's patented design and proprietary assembly process enable precision alignment of capillaries in a coaxial manner.

The K10 can be purchased in three different configurations to enable different chemistries. For a single step reaction of two reagents, the 2T is a simple yet versatile solution. For multi-step reactions involving 3 or 4 reagents, the 3T or 4T may be used. This capability opens doors to multi-step processes or the incorporation of quenching agents, expanding the versatility and applicability of the reactor system.

K10-2T TECHNICAL SPECIFICATIONS

Dimensions	35 x 10 x 4.2cm
Weight	400g
Wetted Materials Selection	ETFE, PEEK, PP, Quartz, Stainless Steel
Minimum Micromixing Time	0.5ms
Maximum Shear Rate	10^6 s^{-1}
Maximum Liquid Flowrate (Total)	500 mL/min
Maximum Air Flowrate	30 L/min
Maximum Pressure	7 bar
Reaction Length	150 mm

ANNULAR MICROREACTOR MODELS

CAPABILITIES	-2T	-3T	-4T
Number of Reagents	Up to 2	Up to 3	Up to 4
Use Case	• Single step process • Manual quenching • Manual tip cleaning	• Multistep processes • Automated quenching • Automated tip cleaning	• Multistep processes • Automated, simultaneous quenching & tip cleaning

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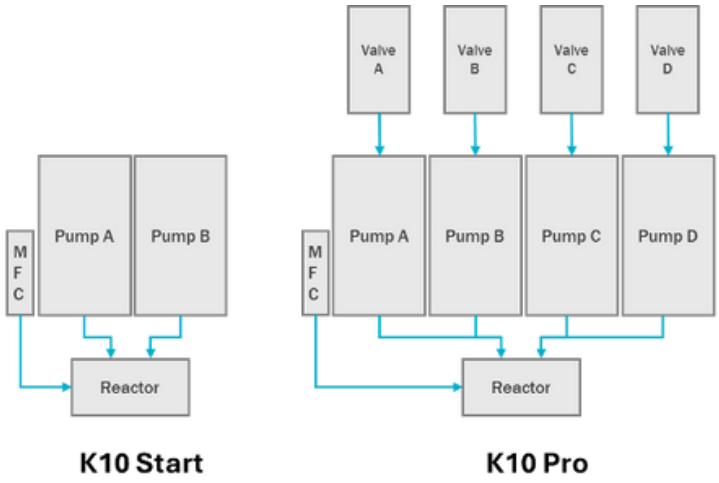
DOSING MODULES

The K10 Dosing Modules are designed to support manufacturing workflows through controlled, traceable, and repeatable reagent delivery. The system incorporates industrial-grade, medium-pressure, low-pulsation pumps for liquid reagents and mass flow controllers for compressed gases. Critical process parameters monitoring, including reaction pressure, with optional upgrades include product pH, conductivity, closed-loop temperature control, extended inline analytical tools, and additional dosing channels to facilitate validated processes and enhanced quality assurance.

START

The K10 Start configuration is intended for simple chemical reaction manufacturing and process scale-up from R&D. It features a continuous, low-pulsation pumping system optimized for higher flow rates while maintaining controlled and reproducible reagent dosing. Integrated pressure sensors provide essential in-process monitoring to support process verification and deviation detection. Reagent changeover and cleaning are performed via defined manual procedures, enabling documented cleaning protocols and operator training. The K10 Start is well-suited for simple chemical processes where process robustness and traceability are required prior to full automation.



K10 Configuration Schematics. Reagent and compressed gas not shown

PRO

The K10 Pro configuration is designed for automated pilot production, process validation, and commercial manufacturing. It incorporates multiple continuous, low-pulsation dosing pumps to support complex, multi-component formulations with precise stoichiometric control. Automated valve systems enable programmable cleaning-in-place and reagent changeover sequences, reducing cross-contamination risk and improving operational consistency. High-precision sensors generate comprehensive real-time process data, supporting enhanced batch documentation, trend analysis, and semi-autonomous process optimization. These capabilities make the K10 Pro well suited for sustained pilot production, process validation studies, and risk-reduced scale-up.

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CAPABILITIES – START & PRO

CAPABILITIES	START	PRO
Air Dosing	• 1 x Mass Flow Controller • 30 SLPM Max	• 1 x Mass Flow Controller • 30 SLPM Max
Liquid Dosing	• 2 x Low Pulsation Pumps • 10 bar max • 50 - 250 mL/min max	• 4 x Low Pulsation Pumps • 10 bar max • 50 - 250 mL/min max • 4 x Selector Valves (4 Port)
Dosing Sensors	• 3 x Pressure Sensors (1 x Gas, 2 x Liquid Sensors) • 0.1 bar accuracy	• 5 x Pressure Sensors (Liquid) (1 x Gas, 4 x Liquid Sensors) • 0.1 bar accuracy
Analytical Sensors	Optional: pH, conductivity	Optional: pH, conductivity
Automated priming & rinsing	None	Included
Max Number of Reagents	2	4

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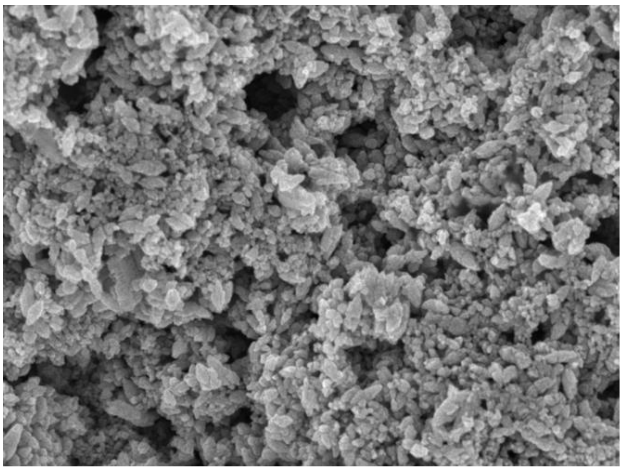
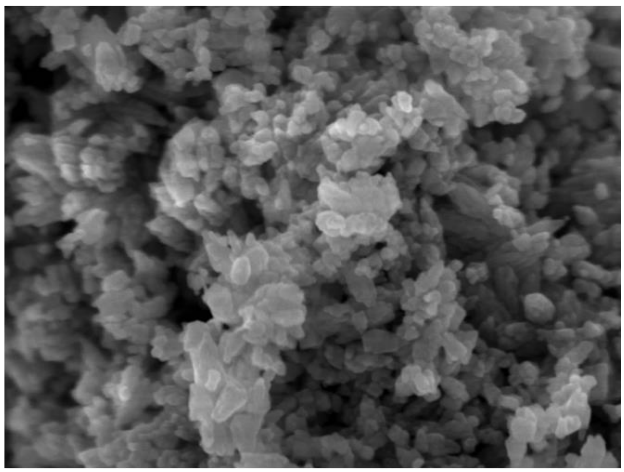
MATERIAL CAPABILITIES

FAMILIES	• 2D Materials • Metals • Metal Oxides • Metal Organic Frameworks • Quantum Dots • Organic Nanoparticles • Ceramics
SIZE RANGE	<5 nm to 5 um
MORPHOLOGIES	Spheres, Flakes, Rods, Stars and more
THROUGHPUT (DRY BASIS)	10 kg/day

EXAMPLE OF SCALE-UP FROM K1 TO K10 SYSTEM



ZnO morphologies synthesized with K1



ZnO morphologies synthesized with K10

To see relevant publications, please visit https://acceleratedmaterials.co/nanomaterials/

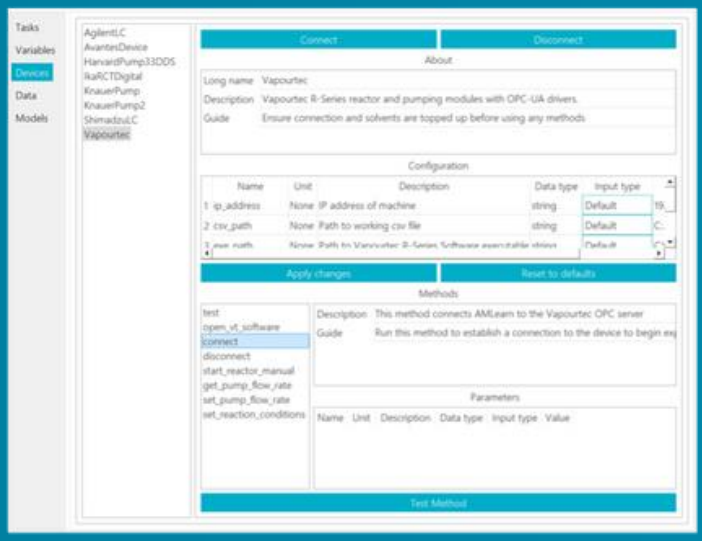
LEARN

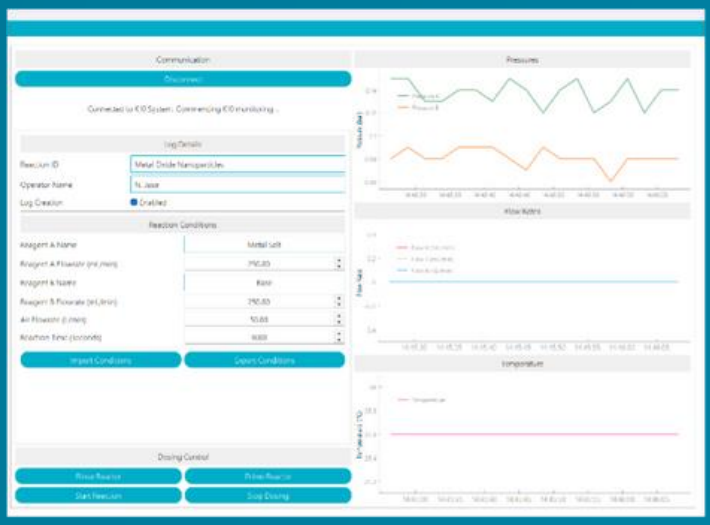
K10 reaction systems are easily operated with AMLearn, an operating system for advanced equipment control, automation and machine learning integration. AMLearn contains apps for AM's equipment as well as our proprietary machine learning methods for data analysis and optimization. These capabilities significantly reduce the time and cost of manual experimentation.

Users can rapidly create reliable and scalable synthetic protocols for quick transfer reaction conditions obtained on K1.

DASH

- Precision Dosing: Control flow rates and reaction times with exceptional accuracy for consistent, reproducible results.
- Automated Workflows: Schedule experiments, automate repetitive tasks, and free up your time for characterization and development.
- Real-time process monitoring: Monitor reaction conditions to ensure safety and optimize process parameters.





K10

- Precision Dosing: Control flow rates and reaction times with exceptional accuracy for consistent, reproducible results.
- Automated Workflows: Schedule experiments, automate repetitive tasks, and free up your time for characterization and development.
- Real-time process monitoring: Monitor reaction conditions to ensure safety and optimize process parameters.
- Data Management: Import/export reaction recipes seamlessly and generate detailed data reports for comprehensive analysis.

OPTIMA

- Advanced Optimization for Chemical Processes: Employ sophisticated algorithms to intelligently predict optimal reaction conditions, solvent choices, and balance multiple objectives in complex chemical processes.
- Code-Free Workflow Integration: Utilize a user-friendly, graphical interface to design and execute AI-driven optimization protocols without the need for coding expertise.
- Streamlined Automation: Design and execute AI-driven optimization workflows with ease using a code-free, intuitive graphical interface.

K-SERIES

INDUSTRIAL CASE STUDY: SYNTHESIS OF NANO ZINC OXIDE

K1 K10 K100

Nano zinc oxide is a highly versatile industrial material, with applications ranging from sunscreen to electron transport layers.

Unfortunately, it is a particularly challenging material to efficiently scale-up, due to the wide diversity of morphologies, sizes and crystalline structures it can form.

To demonstrate the industrial viability of our K-series reactors, we have successfully scaled up the manufacture of morphology-controlled nano zinc oxide with the K1, K10, K100 systems in a matter of months.

Compared to conventional batch synthesis methods, the approach exhibited the following benefits:

- Reduced labour in both experimental time and manufacturing personnel, especially useful for constrained R&D timelines
- Reduced space usage – a K1 replaces a 50 L reactor, while a K100 replaces a 10,000 L reactor - saving valuable factory and laboratory space.
- Preservation of product uniformity across 1, 10 and 100 kg/day scales, without the need for additional optimization.

Collectively, these advantages deliver a return on investment improvement of up to 90%.

Detailed specifications for nano zinc oxide and other morphology-controlled materials are available in our Materials Catalogue at https://acceleratedmaterials.co/materials-catalogue/

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TECHNO-ECONOMIC ANALYSIS RESULTS

	GRAMS - KILO		KILO		KILO - TONNE	
PARAMETERS	**K1**	**50 L Reactor**	**K10**	**1,000 L Reactor**	**K100**	**10,000 L Reactor**
Capacity kg/day	1	1	10	10	100	100
# of experiments per day	10	1	1	0.5	1	0.2
Space Requirement (sqm)	1.5	5	3	25	25	100
Production Cost $/kg	$254.00	$509.00	$20.00	$50.00	$15.00	$33.00
Total Investment	$43,185.00	$126,833.00	$203,750.00	$692,387.34	$576,100.00	$4,155,871.71

TOTAL COST REDUCTION

CAPACITY (KG/DAY)	1	10	100
CAPEX REDUCTION ($)	$ 83,648.00 (66%)	$ 488,637.34 (71%)	$3,579,771.71 (86%)
OPEX REDUCTION ($/KG)	$ 255.00 (50%)	$ 30.00 (60%)	$18.00 (55%)

YEARS TO BREAKEVEN (AT $50/KG)	~6 months (reduction of 8.47 years)

GET YOUR K10

PACKAGE

AM's standard K10 package consists of:

- The K10 Start or Pro along with the desired reactor (-2T, -3T or -4T)
- 1-year of customer service, including remote installation guidance, training and troubleshooting
- 1-year warranty on dosing and reaction equipment

PROOF OF CONCEPTS & SERVICES

Unsure if the K10 is right for your application? Need additional services or customization? AM offers proof-of-concept projects, rent-to-own schemes, and R&D services to enhance your K10 purchase.

CONTACT

To request a quotation or get more information, contact AM's team at sales@acceleratedmaterials.co.uk