Advanced in vitro exposure systems











VITROCELL® Flow 4

Next generation exposure module for in vitro inhalation toxicology – for continuous flow with enhanced capabilities

Universal Exposure Module

6-, 12, and 24-well sized inserts

VITROCELL® Continuous Flow Exposure Systems have set the standard for exposing cell cultures to a dynamic range of gases, complex mixtures or particles. Now we introduce the new generation of exposure modules.

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This NextGen module isn't just an addition to our lineup; it's a transformative platform that redefines what's possible in inhalation toxicology in vitro. Here's why:

Versatility

The universal platform accommodates 6-, 12- and 24-well sized inserts, making it adaptable to a wide range of research needs.

Precision Temperature Control

Electrically heated top and base ensure a stable environment at 37°C, with LED indicators for readiness, ensuring your samples are maintained at optimal conditions.

Removable media compartments made of stainless

Removable media compartments made of stainless steel for quick and easy cleaning.



Exchangeable aerosol inlets ensure a versatile use of exposure module. The top and base modules incorporate integrated electrical heating.



Simplified Operation

Experience hassle-free locking/closing in combination with a "sandwich" design for easy handling. The specially engineered 0-ring mountings ensure quick 0-ring exchanges and super tight sealing.

Advanced Monitoring

Optional in-cavity measurements of relative humidity and temperature provide a detailed and online view of cell relevant exposure data.

Integrated Design

Full QCM compatibility and a seamless integration into VC Monitor Software: you manage to visualize up to 5 exposure modules via one power-hub.

Elevate Your Research

With the VITROCELL® NextGen Modules it has never been easier for researchers to explore the frontiers of aerosol science. We present the future of in vitro inhalation toxicology research with our new platform that combines versatility, precision control, and ease of use.



Easy-to-use closing and locking mechanism (left). Interface connectors for real-time data visualization (right).



Full QCM compatibility and connectivity to VITROCELL® Monitor Software.

Key Features:

- Universal platform for different insert sizes and brands: 6-, 12- and 24-well sized inserts
- Electrically heated top and base with LED indicator when ready to use (heated up to 37°C)
- Hassle-free locking/closing mechanism
- Sandwich design simplifies handling
- \circ Pre-defined inlet height according to the used insert sizes
- \circ Easy O-ring mounting for super tight sealing

- In-cavity relative humidity and temperature measurement capabilities
- Optional Thermophoresis feature
- Full QCM compatibility
- \circ Removable media compartments for easy cleaning
- Fully integrated into VC Monitor Software (1 to 5 exposure modules connected via power-hub)
- Designed for highest durability and long lifetime



VITROCELL® AirTox Monitor

Highest automation and reproducibility



The VITROCELL[®] AirTox Monitor is designed for automated exposure of lung cell cultures at the Air/Liquid Interface with full control of all relevant parameters such as temperature, humidity, exposure duration and flows.

The complete system with AirTox Monitor, control cabinet and water baths. Special focus was set to minimize the needed lab space and increase reproducibility in a lab environment with frequently changing staff.

The VITROCELL® AirTox Monitor ensures this reproducibility by a user-friendly control software. All relevant process steps of the cell exposure are automatically prepared and key parameters such as temperature and humidity are controlled to target values of the recipes.

A high degree of automation and user guidance ensures reproduceable conditions day-by-day independent of the operator or location.

For increased flexibility in the experimental setup, the system can be connected to a wide range of aerosol sources. The new size-selective PM inlet offers defined ranges of particle sizes to the exposure module. Flow rates can be adjusted according to the sensitivity of the cell culture system.

User guidance

The control software is especially designed to provide an intuitive and guided operation of the AirTox Monitor.

The user determines all relevant process parameters in advance of an experiment and stores them in recipes.

For the upcoming experiment, the operator simply selects the desired recipe from the list and starts the experiment.

The system automatically carries out all process steps according to the specified parameters. Here the operator is supported with stepby-step instructions for system preparation, conduct of experiment and post-processing.

Tablet PC for easy and intuitive use.

Back side with filter unit and service tray housing the mass flow controllers.

Easy and swift maintenance

In designing the AirTox Monitor, particular emphasis was placed on easy access to components that need to be regularly checked and maintained. Service trays on the front and back side of the system ensure quick and easy access to filter elements, mass flow controllers or condensate tanks. Slide doors on the front and back side provide easy and quick access to the exposure modules, aerosol tubing, filter unit and aerosol reactor.

Easy and quick access to the exposure modules, aerosol tubing, filter unit and aerosol reactor.

Reproducibility

In order to ensure high repeatability, the aerosol is extracted isokinetically from the main flow. The sample flow is then guided to the exposure module, where cell cultures are exposed at the Air/Liquid Interface. In the new VITROCELL® Adaptive Isokinetic Sampling, different flow pairings are available which were characterized with a fluorescein sodium aerosol.

The heating unit ensures improved temperature stability, which is key for long term exposure. Together with a separate water dosing unit, exposure durations for up to 24h become now possible.

A separate VITROCELL® 6/1 exposure module can be equipped with dosimetry tools such as QCM, TEM-Inserts or dosimetry inserts for chemical trapping. This allows the characterisation of the aerosol within the exposure module at the same location where cells are exposed.

	Mean value	STD
RH aerosol reactor (% r.h)	85.00	0.25
RH clean air (% r.h)	85.00	0.06
T cabinet (°C)	37.05	0.12

Typical values over the exposure duration of four hours.

The sample flow is guided to the exposure module, where cell cultures are exposed at the Air/Liquid Interface.

Flow pairing		Deposited mass of fluorescein sodium	
Main flow (I/min)	Sample flow (ml/min)	Mass* (ng * cm ⁻² * h ⁻¹)	Deviation
16.67	100	74.21 +/- 1.73	2%
8.33	50	183.73 +/- 5.80	3%
16.67	50	54.35 +/- 3.49	6%
8.33	25	127.19 +/- 7.69	6%
16.67	25	50.10 +/- 3.57	7%

* mean of 4 positions

Deposition of fluorescein sodium for different flow pairings with the same aerosol source.

Key Features:

- Direct aerosol sampling
- \circ Size-selective PM Inlet
- Adaptable Isokinetic Sampling
- \circ Exposure durations up to 24h
- Dosimetry tools (QCM, TEM-Insert, Trapping)

- \circ Intuitive HMI with user guidance
- High day to day reproducibility
- \circ Easy and swift maintenance
- \circ Flow control by mass flow controller
- \circ Compact and fully automated solution

VITROCELL® Cloud Alpha Plate

Interchangeable base modules for 24- and 96-well HTS plates

The latest innovation of the VITROCELL® Cloud Alpha can now be equipped with 24-Well and 96-well HTS plates. With its modular design, this advanced platform is tailored for higher throughput demands and enables a rapid and efficient execution of experimental series.

The removable and easy to clean stainless-steel base modules allow for aerosol deposition without significant influence from electrostatic effects.

More flexibility thanks to interchangeable base modules with different well sizes (left) and an integrated sQCM 12 sensor (right).

Dosimetry using Quartz Crystal Microbalance (QCM)

The sQCM 12 sensor seamlessly integrates into the Cloud Alpha Plate exposure module. It offers precision measurement of deposited mass, down to nanograms/cm².

All results are logged within the VITROCELL[®] Monitor Software, where they are presented graphically and can be effortlessly exported to MS Excel[®] for further analysis.

Choice of three types of nebulizers

VITROCELL® offers a selection of three types of vibrating mesh nebulizers, each with specific droplet MMAD ranges: $2.5-6.0 \mu m$, $2.5-4.0 \mu m$, and $4.0-6.0 \mu m$. An advanced version is also available with a range of $9.0-12.0 \mu m$. This versatility makes it particularly suitable for testing whenever limited quantities of testing materials are available.

Features:

- \circ Suitable for nebulization of solutions and suspensions
- Higher throughput in using HTS plates
- Uniformly distributed Cloud exposure of cells in 24- and 96-well HTS plates
- Base modules made of stainless steel for minimized electrostatic effects
- Optional sQCM 12 microbalance
- Optional PowerVent function: evacuation of residual aerosols via vacuum pump
- Designed for screening of inhaled drugs, toxicity testing of inhaled substances such as chemicals or nanoparticles and virus research

VITROCELL® 96

For 96-well HTS plates

High-Throughput 11 dilutions / 1 clean air control @ 8 replicates

The VITROCELL® 96 Exposure System has been specifically designed and engineered to facilitate the research of cell cultures in direct exposure to airborne substances such as gases, complex mixtures and particles including nanoparticles. The system authentically mimics physiological relevant exposure conditions.

Docking Station with Base Module (1) and Quick Lock Dilution System (2)

Up to 11 dilutions with 8 replicates are used for exposure to test substances and the 12th insert row for clean air control with 8 replicates.

Climatic Chamber

The system is integrated in a Climatic Chamber which enables a stable temperature of 37°C for all components. The benefits are condensationfree operation and a stable humidity level throughout the exposure.

Docking Station for Base Module and Exposure Top

The docking station guarantees a hermetic connection of the base module with the aerosol exposure top. The flow rate for each of the 96 inlets is controlled and maintained by critical orifices which are connected to a vacuum pump.

DNA strand-breaking activity (Genotoxicity | Comet assay)

12 0.5

PC EMS Ctrl.

10 7 11 8

Performance Qualification

The system was evaluated in a comprehensive performance qualification using combustion cigarette aerosols. As a conclusion, the system is fit for purpose.

0	<u>11</u>	Dilution	Steps:
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• Cigarettes:

1R6F • Smoking Regime: **Health Canada** 5 Cigarettes à

0,5-81/min Air

- Puff number:
- 8 puffs 55 ml

2s

8s

- Puff volume:
- Puff duration:
- Exhaust duration:
- Number of experiments: 3

Key Features:

- \circ Base module for 96-well HTS plates
- 12-fold Dilution/Distribution System
- \circ 12 mass flow controllers for humidified air
- \circ 11 dilutions @ 8 replicates
- 1 clean air control @ 8 replicates
- Electronic heating system for base module and exposure head

 \circ Exposure head with 96 critical orifices and filter system

HTS-plate columns Dilution mass flow (I/min)

- Climatic Chamber for condensation-free operation if using liquid aerosols
- Housing with double-doors

40

30 27.3

20

10-

1 0.5 2 3 1.5 4 2 5 2.5

% DNA in tail (Mean ± SEM)

32.3

19.4

- \circ Heating systems with two sensors for temperature monitoring
- Integrated humidification system

VITROCELL® CalorQuanti

An innovative optical dosimetry tool for real-time deposition monitoring

The latest innovation of online dosimetry assessment was developed in a joint project of NanoLockin and VITROCELL®. The new CalorQuanti can be used to optically analyze the particle dose in VITROCELL® Cloud Alpha Systems or as standalone unit.

It uses an innovative lock-in thermography system, which allows to measure the heating of particles upon light irradiation. The amount of heat produced can be correlated to the deposited dose.

Function Principle

- 1. Laser pulses light on ALI
- 2. Particles and cells emit different IR-radiation
- Lock-in thermography allows for analysis of temperatures differences in the mK range
- 4. The measured heat can be correlated to the particle concentration

Source: Adolphe Merkle Institute, University of Fribourg, Switzerland

Key Features:

- Allows for non-invasive, real-time dosimetry
- Particle deposition is measured on living cells, directly at the air-liquid interface
- Does not sacrify a cell culture position in the exposure system
- Capable of analyzing particle types with darker color: combustion particles (e.g., diesel and aircraft emissions), tire wear particles, metal particles, break wear particles, carbon particles (graphene, carbon black and nanotubes)
- \circ Also available as standalone version

VITROCELL® Photometer 2.5

A big step forward in photometric dosimetry

VITROCELL® Photometers have always provided precise, lossfree particle concentration measurements at low flow rates. Supported by easy-to-use software, these devices demonstrate our commitment to enhancing aerosol measurement technology.

Our newest version, Photometer 2.5, is a significant update to this. We achieved enhanced robustness and connectivity by switching to pure digital data transfer via USB-C. Featuring preadjusted delivery and self-identification, Photometer 2.5 makes it much easier to prepare and document your experiments in compliance with good laboratory practices (GLP). This also makes your results directly comparable world-wide, without the need to conversion or harmonisation.

New Photometer 2.5 installed in AirTox Monitor.

Powered and connected to a PC or a hub via UCB-C.

New Key Features:

- Factory adjustment eleminates the need for any harmonization
- Self-identification in Monitor Software with its serial number, ensuring fail-prove data mapping
- \circ Less documentation effort for users, especially for GLP
- Digital-only data transfer via USB-C, allowing for easy and robust connectivity without controller boxes
- Works with latest Vitrocell Monitor Software 2.5

About VITROCELL®

VITROCELL® exclusively concentrates on the developing, producing, installing, training and servicing of advanced *in vitro* exposure systems.

The VITROCELL® Systems' team is driven by their vision for new in-vitro standards through state-of-the-art technology, highly qualified workmanship and absolute client dedication. VITROCELL® has successfully collaborated with clients from leading research institutes, contract research organizations, regulatory authorities or industrial laboratories across the world. Working with our team experts, all modules have been tailored to create durable and complete turnkey-systems for *in vitro* inhalation toxicology. Gases, environmental atmospheres, nano particles and complex mixtures are analyzed on lung cells at the air/liquid interface using these systems. VITROCELL® technologies are also applicable to solutions for skin research.

Over a decade of devotion to research in this specific field has given our team of design & precision manufacturing specialists the opportunity to mentor highly diversified and complex projects from conception to completion. We strive to become a constructive member of each research team, providing support when it is needed, advice when it is required and modules of the highest quality, which are even polished by hand before leaving here to be integrated into your workspace. Every piece of our German engineered equipment is manufactured to the highest of standards – yours.

For more information please scan the QR-Code:

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