ocean

IN SITU LIQUID SOLUTIONS FOR TEM PLATFORMS

Solutions for **In Situ Microscopy**

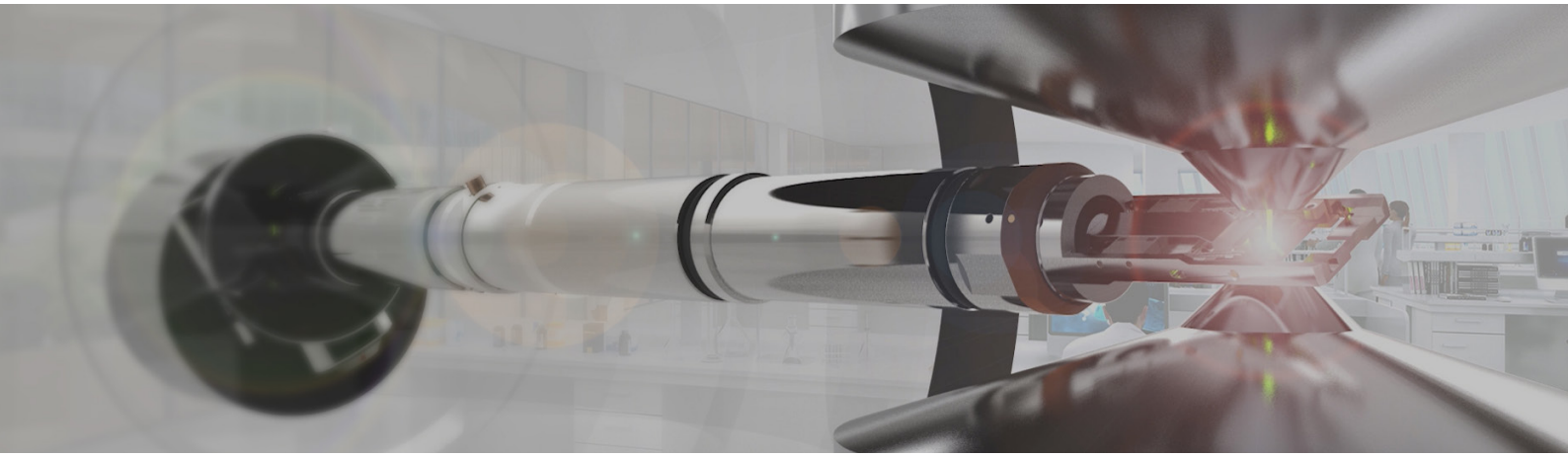
THE OCEAN SERIES

Observe the real-time dynamics of materials and biological samples in a controlled liquid environment.

OCEAN FEATURES

Absolute TEM safety.
Customize your experiments.
No cross-contamination or clogging.
Static & flow modes.

DENS solutions



Changing the world, **one atom at a time**

It's widely accepted that nanotechnology is essential to solve many of the global challenges which human society is facing today. These modern day challenges, influenced by a growing population size, increased energy demand and climate change are factors which push scientists to solve macro problems, starting from the bottom-up!

As scientists, we strive to understand materials down to the atomic level, and the TEM has proved itself to be a powerful tool to capture important nanostructural information. However, the TEM imposes a limitation by means of static sample environments and high vacuum pressures. This limits the ability of researchers to fully investigate real-world phenomena and achieve breakthrough science.

What if there were a way to look into the nano-world and observe dynamic phenomena related to materials in chemical reactors, aeroplane engines or solar panels? The answer is in situ TEM.

Using the latest in MEMS technology, we have engineered this into a reality by introducing dynamic stimuli to the TEM and crossing the pressure gap.

With the help of our range of in situ TEM solutions (heat, bias, gas & liquid), you can record the evolutionary dynamics of your sample and understand the unknown.

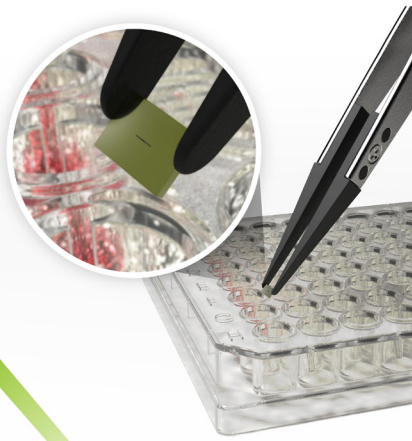
Change the world, one atom at a time!

Wildfire	**Lightning**	**Climate**	**Ocean**
Heating	Biasing	Gas	Liquid

In Situ TEM **Liquid**

The Ocean In Situ TEM Liquid Series empowers researchers to image materials and biological samples in a contained MEMS based fluidic reactor – called the Nano-Cell. The latter ensures the sample is fully hydrated. The system allows to work in either a static or flowing condition. This Ocean Series opens up many new and exciting research fields, and transforms your TEM into an in situ liquid laboratory.

Ocean In Situ TEM **Workflow**

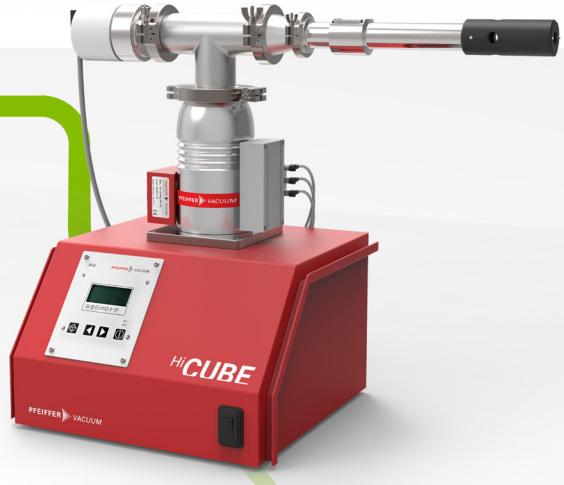


Nano-Cell Sample Preparation

The Ocean Series consists of a dual chip Nano-Cell that sandwiches two chips together to form a microfluidic compartment. Samples can be loaded or grown directly on the chip in the field of view, removing the need to flow the sample into the cell or drying, fixing and freezing.

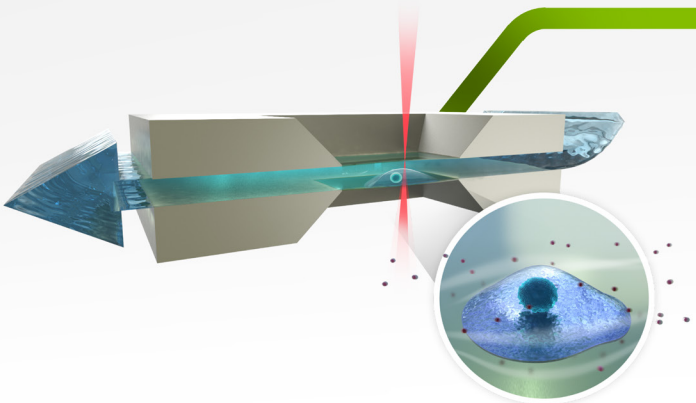
Loading the Nano-Cell

The Nano-Cell is loaded in a precision made slot that ensures the electron transparent windows remain aligned and ready for safe and reliable experiments.



TEM Safety Leak Testing

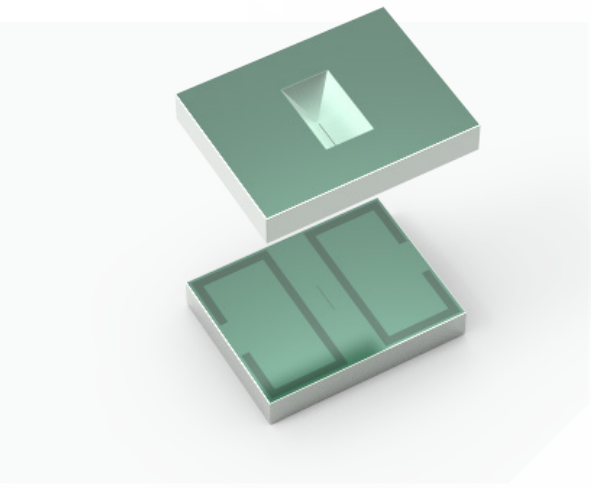
The Ocean Series is equipped with a high vacuum leak tester to safeguard the integrity of the TEM column. This system certifies that the holder is completely sealed from any leakages and is vacuum compatible.



Real-Time Liquid-Phase Processes

The Ocean Series enables researchers to achieve nanometer resolutions and image the real-time dynamics of a sample using static and flow modes in a fully hydrated Nano-Cell. The Ocean Series provides the understanding of fundamental processes and opens the door to a range of exciting new applications.

What makes the **Ocean Nano-Cells** unique



1 Extremely clean Nano-Cells

- High quality micro-fabrication techniques
- No cross contamination

2 Easy to assemble, reliable in performance

- Customization of the experiment by spacer range
- Most cost effective nano-cells for statistical studies

3 Optimal stability

- Robust SiNx windows with very low mechanical stress
- Reliable handling of Nano-Cell

What makes the **Ocean Platform** unique

1 No cross-contamination or clogging

- Modular design
- Replacable tubing, tips and Nano-Cells

2 Optimized for TEM and STEM analysis

- Tip can be rotated by 180°
- Easy switch from TEM to STEM mode

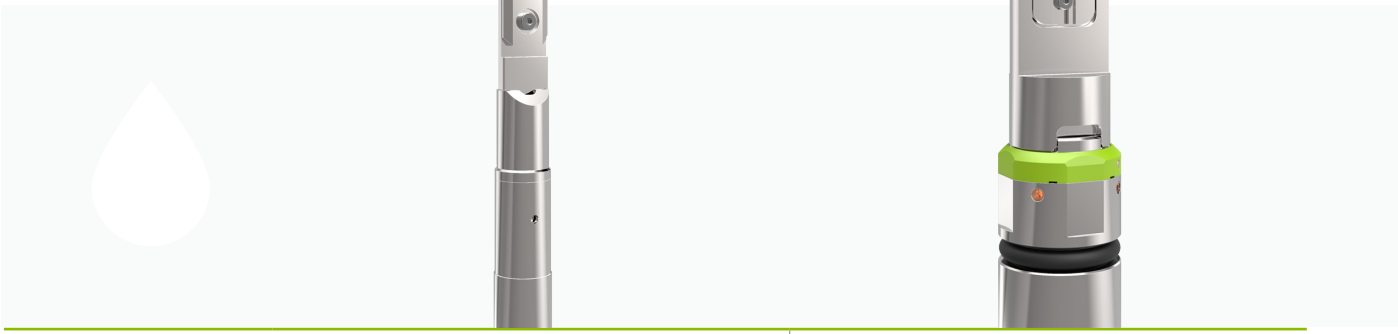
3 Self alignment for a secure experiment

- Tip closure is “error proof” and not dependent on the applied force
- Self-alignment of the Nano-Cell

Nano-Cell Specifications*

Outer Dimensions	2.00 x 2.60 mm
Window Dimensions	0.050 x 0.40 mm^2 (intended for a thick liquid layer) 0.020 x 0.40 mm^2 (intended for a thin liquid layer) 0.010 x 0.40 mm^2 (intended for a thin liquid layer) 0.40 x 0.010 mm^2 (crossed window)
Thinnest Available Spacer	200 nm (suitable for nanoparticles)
Thickest Available Spacer	5 µm (suitable for cells)
Window's Thickness	< 50 nm

Platform Specifications*



	FEI COMPATIBLE Ocean S3	JEOL COMPATIBLE Ocean S3
Fluid Control Method	Syringe Pump	Syringe Pump
Flow Modes	Static / Continuous	Static / Continuous
Liquid Manipulation	Infusion / Withdrawal	Infusion / Withdrawal
Maximum Flow Rate *1	10 µL/min	10 µL/min
Minimum Flow Rate *1	25 nL/min	25 nL/min
Resolution *2	≤ 5 nm	≤ 5 nm
Compatability (Pole Piece)	ST, XT, T, BioT	HRP, HTP, CRP, HCP
(HR) TEM	✓	✓
(HR)STEM + EELS	✓	✓

*1 Depending on pump specifications.
*2 Depending on the liquid thickness provided by the spacer height.

In Situ TEM **Liquid Research**

Historically, the low magnification possibilities of the light microscope have limited researchers' understanding of samples. Investigating in their native environment or observing the complete reaction process has always been the key to better scientific understanding. Almost 80% of all microscopy investigations are carried out with light microscopy exhibiting a limited spatial resolution. Scientists' desire to study samples of dimensions smaller than 20 nm has resulted in the increased interest into electron microscopy. However, standalone transmission electron microscopes are limited by stimuli free environments and has further restricted researcher's ability to a number of applications. This limitation is now lifted giving TEMs additional value in being able to image real-world sample dynamics in a liquid environment.

Life Sciences

The sample damaging technique of drying, fixing and freezing has limited researchers' ability to further understand a range of bio related samples. Enabling native environment research, the Ocean Series removes the need for these techniques and allows nanometer resolutions to be obtained while preserving the original morphology of the sample. Additionally, the ability to grow bio samples directly on the bottom Nano-Chip in a multi-well further highlights the Oceans Series value in allowing scientists to understand their sample in the native environment.

Chemistry & Materials Science

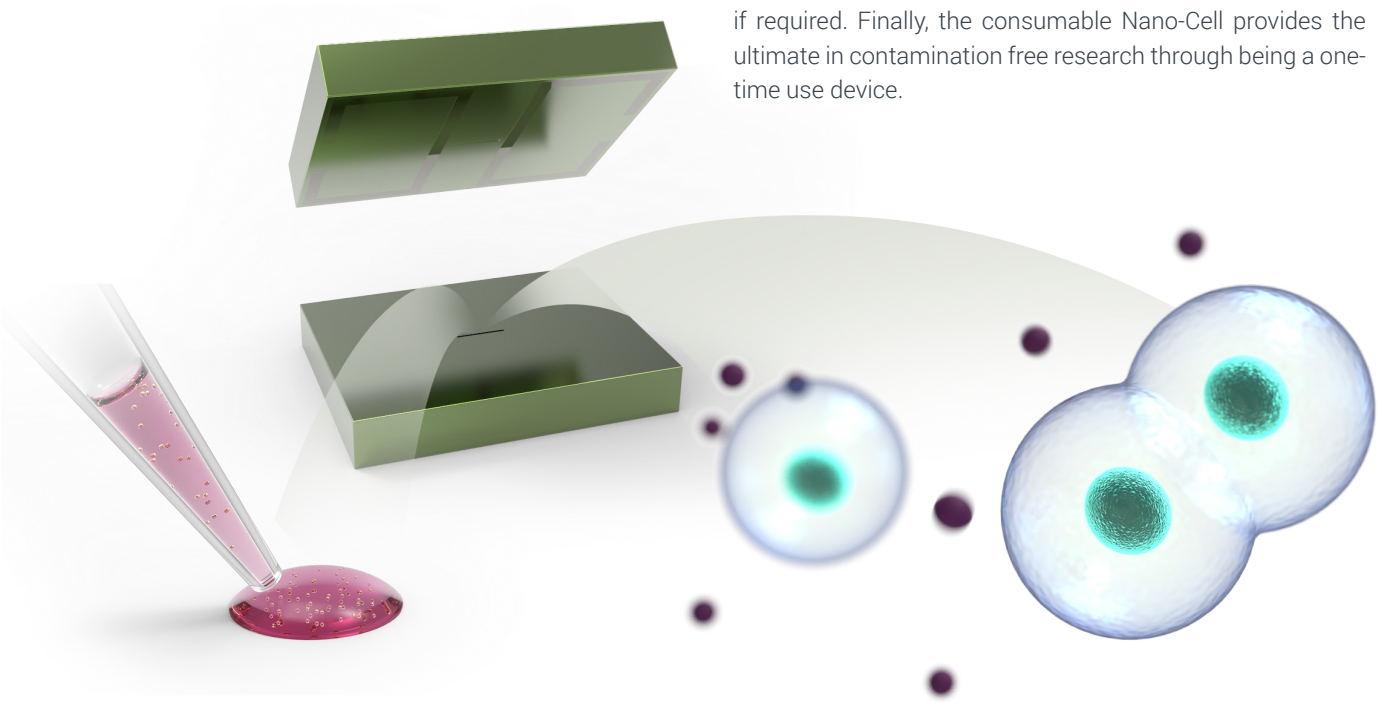
The unique dual chip Nano-Cell offers researchers' the ability to observe the complete chemical reaction, imaging each critical moment of real-time dynamics. The Ocean Series allows the liquid conditions to be regulated for total control of the chemical interactions and enables optimization of processes and properties of the material.

TEM **Safety**

Critical to all forms of in situ research is upholding the safety and security of the TEM column. The Ocean Series is equipped with an advanced leak tester that tests vacuum compatibility and guarantees that no liquid will escape once inserted into the TEM.
Each Nano-Cell is made from silicon nitride and has been rigorously tested for membrane strength under high pressures. The robust electron transparent windows have been optimized to prevent mechanical failure from changes in pressure and alternating flow rates.

Replaceable Tubing & Tip

Ensuring a clean environment, free from contamination and without the risk of clogging is critical to a user's results. The Ocean Series' unique design allows for all inner tubing and tip to be completely removed from the holder and replaced with new uncontaminated replacements, guaranteeing a clean experiment. The tip of the holder can be detached from the holder for easy and thorough cleaning and replaced if required. Finally, the consumable Nano-Cell provides the ultimate in contamination free research through being a one-time use device.



Application Fields*

(S)TEM experiments in Chemistry

- Nano Particles:
  - Growth processes
  - Nanoparticle aggregation
- Self-assembly processes
- Chemotaxis processes

(S)TEM experiments in Materials Science

- Understanding of reactions in energy materials
- Addressing microstructures of new materials for energy storage
- Examine corrosion processes in steel
- Research on hydrated geological materials
- Applications in petroleum extraction and soil science
- Biomineralization processes

(S)TEM experiments in Life Sciences

- Image protein and DNA (dynamic) structures in liquid
- View self-assembly processes and conformational changes of proteins
- Study of membrane protein function
- Analysing organelles in bacteria and eukaryotic cells
- Correlative light- and electron microscopy of cells
- Nanotoxicology after nanoparticle uptake
- Study effects of drug delivery in cells
- Virology and oncology studies
- Morphological studies of liposomes and other vesicles
- Microbial Production

* These featured examples are for inspirational purposes yet do not cover the entirety of the application range.

Solutions for
In Situ Microscopy

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ocean Liquid