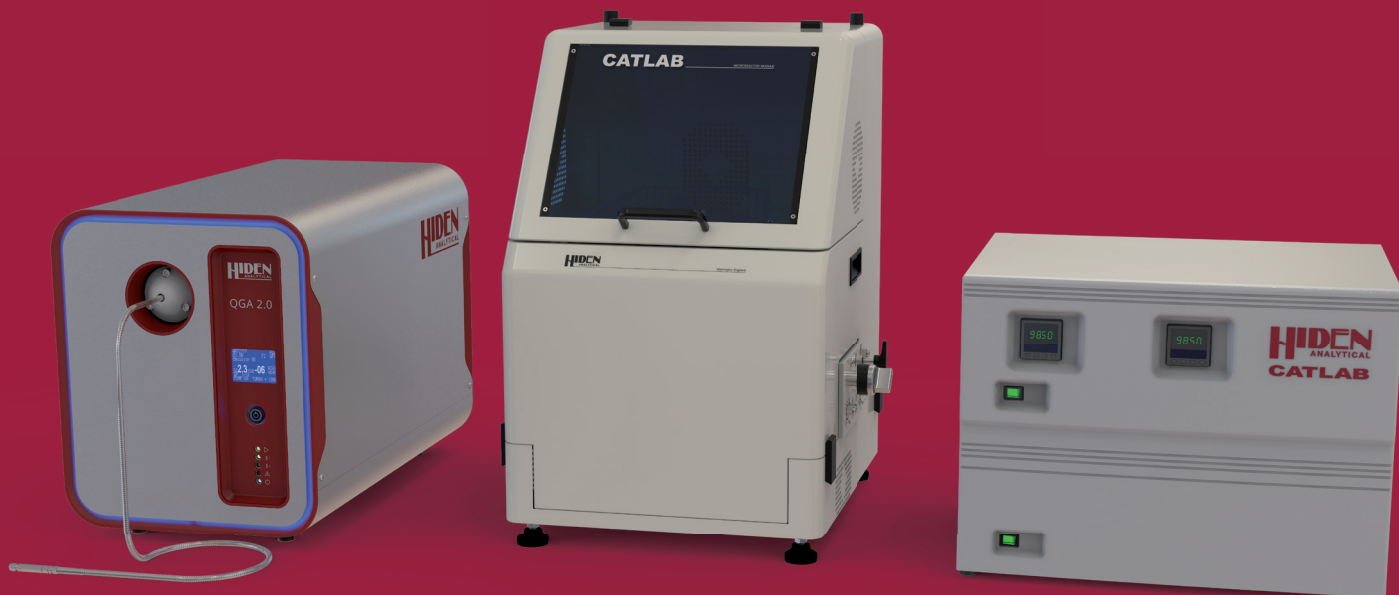




# CATLAB

► Microreactor for Catalysis Studies & Thermal Analysis

# Detailed product information / introduction



**A combined bench-top microreactor and mass spectrometer system for rapid and reproducible catalyst characterisation and reaction studies.**

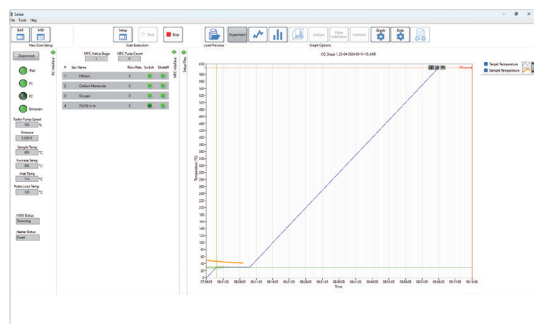
## Applications:

- ▶ TPD/TPO/TPR/TPRx
- ▶ catalysis
- ▶ catalyst screening
- ▶ pulse chemisorption
- ▶ pulse calibration
- ▶ dispersion measurements
- ▶ adsorption isotherms
- ▶ reaction studies

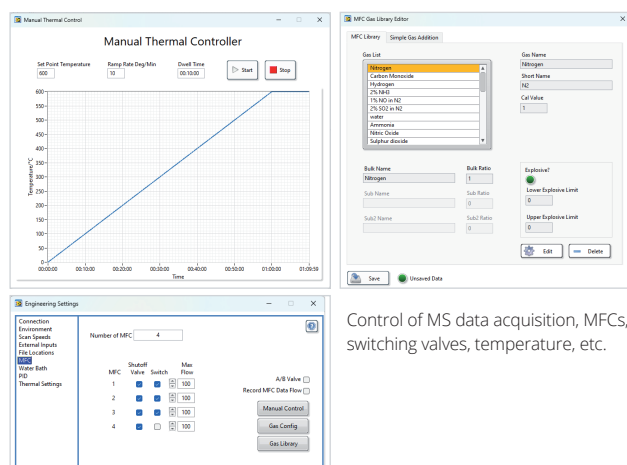
## Key Features

- ▶ Fast response, low thermal mass furnace with integrated air-cooling
- ▶ 1-20°C/min heating rates up to 1000°C
- ▶ Hiden's unique interchangeable Catalyst Cartridge System
- ▶ Close-coupled hot-zone evolved species probe & direct QIC inlet for <500 ms response
- ▶ 'In-Bed' thermocouple for direct catalyst temperature measurement
- ▶ Automatic 4 (8 optional) gas stream manifold or combined gas/vapour manifold
- ▶ Independent Mass Flow control of each channel at 3-100 ml/min (other flow options available)
- ▶ Corrosion resistant manifold configurations also available
- ▶ Seamless on-line, real-time studies with data acquisition and PC analysis
- ▶ Air thermostat and trace heating to minimise condensation of vapour feeds/products
- ▶ Shut-off/bypass flow configuration to seal reactor and gas sampling port
- ▶ Vapour generator option for the introduction of vapours such as water, etc.

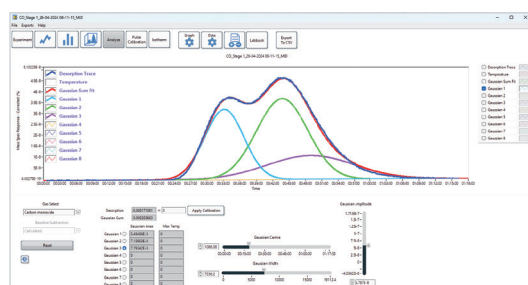
# Software



CATLAB software



Control of MS data acquisition, MFCs, switching valves, temperature, etc.



Peak integration/deconvolution

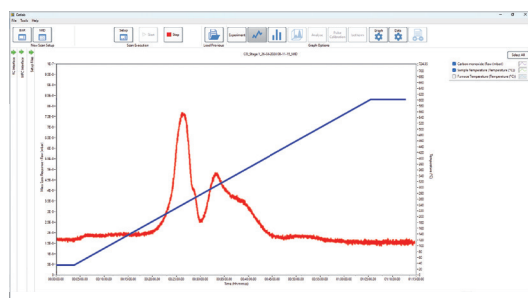


Fig. 1. Temperature Programmed Desorption

## CATLAB Software

A dedicated application specific software package for automated control of MS data acquisition fully integrated with all necessary devices including MFCs, furnace temperature, switching valves, pulse injection, etc.

### Key Features – CATLAB Software

- ▶ Control of the experiment following a user defined temperature profile
- ▶ MS data, temperature and flow all collected in one software package
- ▶ Data analysis routines included in the software for determination of catalyst properties such as metal surface area, dispersion, pulse adsorption isotherms, etc.
- ▶ 10 peak spectral library
- ▶ Automatic subtraction of spectral overlaps
- ▶ Analysis of up to 16 gases

## CATLAB Example Data

Typical CATLAB experiments include temperature programmed studies (TPD/R/O etc.), reaction testing and pulse chemisorption. Some examples are shown:

### Temperature Programmed Desorption (TPD)

Figure 1 shows the results of a TPD experiment of CO from a 1% Pd/Al<sub>2</sub>O<sub>3</sub> sample. TPD experiments are performed by linearly heating a predosed sample and monitoring the evolved gases.

### Key Benefits:

- ▶ High sensitivity mass spectrometer. Detection limit 100% to 100 ppb subject to spectral interference.
- ▶ Close coupled MS for synchronous detection of desorbing gas and temperature measurement.
- ▶ MS data and temperature collected in one software package.

# Software (continued)

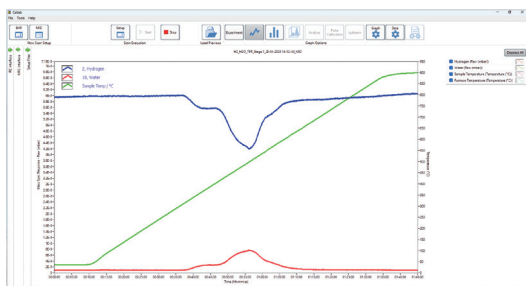


Fig. 2.  
Temperature  
Programmed  
Reduction

## CATLAB Example Data (continued)

### Temperature Programmed Reduction (TPR)

Figure 2 shows the results of a TPR experiment performed on a Ni sample. TPR experiments involve linear heating of the sample under a reducing atmosphere such as  $H_2$ .

#### Key Benefits:

- ▶ High capacity dry pumping system provides optimum performance for applications that use light gases  $H_2/He$  etc.
- ▶ Excellent  $H_2$  sensitivity – more than x2 sensitivity for  $H_2$  compared with published standard RS factors.
- ▶ No need for removal of condensable gases before analysis.

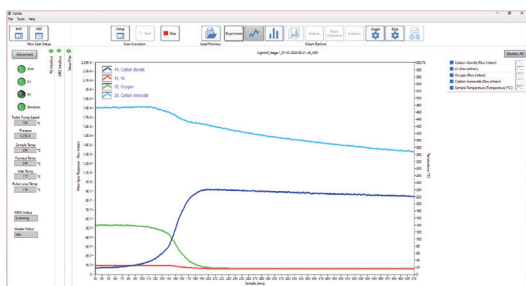


Fig. 3.  
Temperature  
Programmed  
Reaction

### Temperature Programmed Reaction (TPRx)

The TPRx plot in Figure 3 shows the results of the CO oxidation light-off test ( $2CO + O_2 \rightarrow 2CO_2$ ) during a linear temperature ramp to  $500^\circ C$ .

#### Key Benefits:

- ▶ Simultaneous measurement of up to 16 gases/mass species.
- ▶ Heated inlet for sampling of condensable gases, e.g.  $H_2O$  vapour.
- ▶ Soft Ionisation mode for simplified spectra of complex molecules.

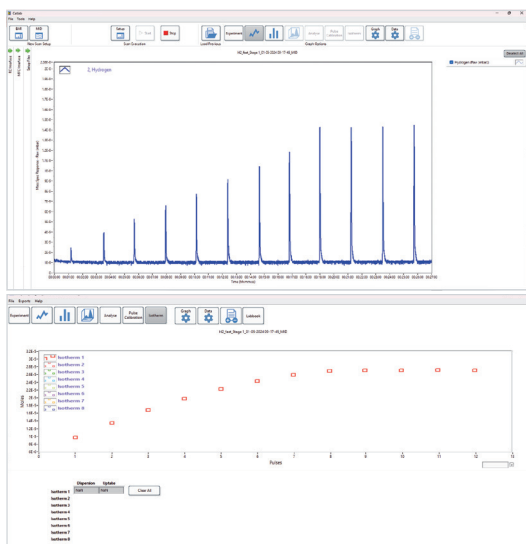


Fig. 4. Pulse  
Chemisorption

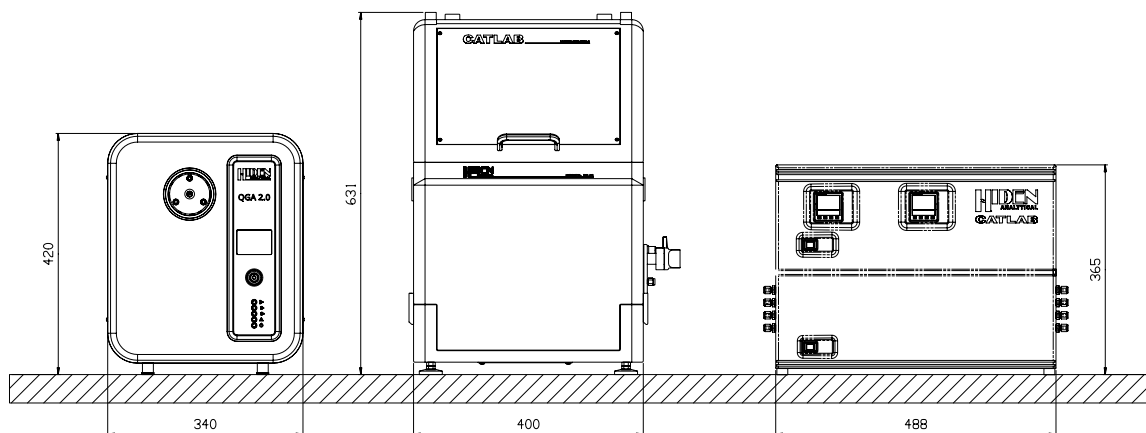
### Pulse Chemisorption

The pulse experiment shown in Figure 4 was performed over a 5%  $Pd/Al_2O_3$  catalyst. The sample was dosed with multiple pulses of CO until saturation was achieved.

#### Key Benefits:

- ▶ Fast data acquisition speeds > 500 measurements/s.
- ▶ Minimal internal volumes reduce peak spreading.
- ▶ < 500 ms response time to changes in gas concentrations.

# Technical Data



## CATLAB MODULE 1

Sample mass:

Reactor sizes (ID):

Pressure:

Temperature:

Accuracy:

Ramp Rate:

Temperature sensor:

Mass flow controllers:

Minimum flow pressure:

Port connection:

Software

Dimensions (L x W x H):

Weight:

Power requirement:

## TECHNICAL SPECIFICATIONS

Typically 25 - 250 mg (up to 2.0 g optional)

4, 7 or 12 mm

Up to 1 bar

Ambient to 1000°C

+/- 1°C

1 to 20°C/min

Type K thermocouple

4 streams 3-100 ml/min standard  
up to 8 streams with user defined flow rates optional

3 bar

1/8" Swagelok

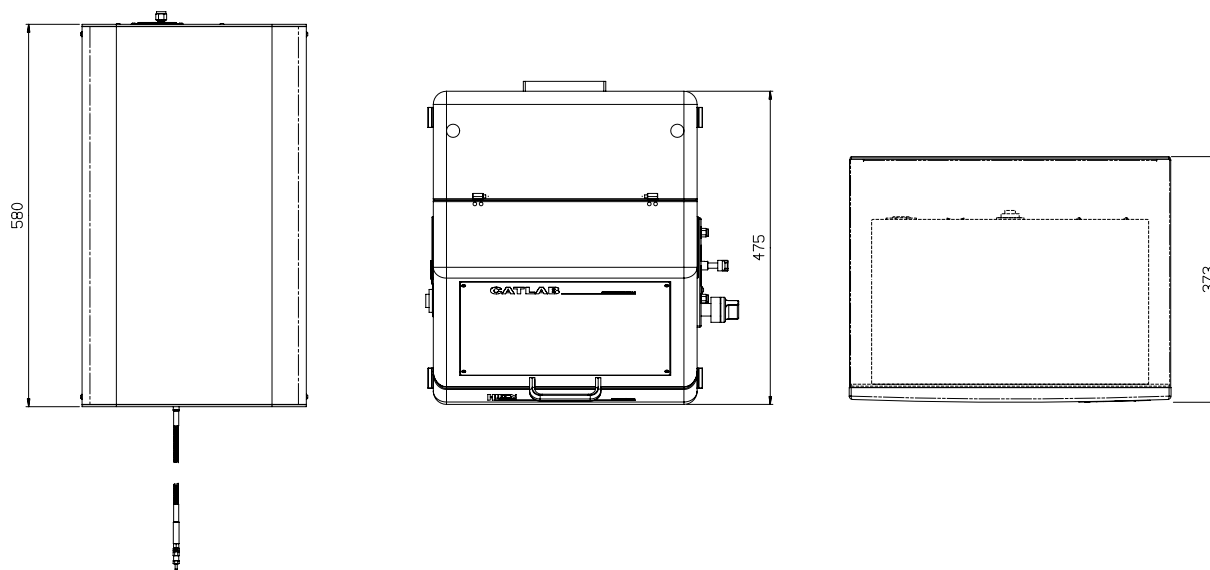
CATLAB Software  
Windows compatible

Microreactor: 631 x 400 x 475 mm  
Electronics Unit: 365 x 488 x 373 mm  
QGA 2.0: 580 x 340 x 420 mm

Microreactor: 30 kg  
Electronics Unit: 27kg  
QGA 2.0: 29.5kg - 33.5kg, depending on configuration,  
Scroll pump 26kg

100-240 V AC, 50-60 Hz, 1.0 kVA

# Technical Data (continued)



## CATLAB MODULE 2

**Mass range, amu:**

**Ion source:**

**Ion source control:**

**Detector:**

**Detection limit:**

**Gas sensitivity:**

**Response time:**

**Quartz Inlet Capillary:**

**Power requirement:**

## TECHNICAL SPECIFICATIONS

Standard 200 amu. Options 300 or 510 amu

Direct inlet high pressure source

All parameters adjustable in real time

Dual Faraday / Channeltron electron multiplier

$5 \times 10^{-11}$  torr with Faraday detector

$2 \times 10^{-14}$  torr with Channeltron detector

Krypton ( $^{84}\text{Kr}$ ) in air at 0.5 ppm with Faraday detector

Xenon ( $^{129}\text{Xe}$ ) in air at 25 ppb with Channeltron detector

300 ms

Typical inlet flow rate/gas consumption 20 atm ml/min

Low flow rate versions to 1 atm ml/min available

100-240 V AC, 50-60 Hz, 1.5 kVA

## FURTHER SYSTEM OPTIONS

Corrosion resistant upgrade for Modules 1 & 2

Vapour generator

# System Configuration & Options

ITEM	DESCRIPTION	PARTCODE
SYSTEM	<p><b>CATLAB-PCS Module 1: The Microreactor System</b>            A Quartz Microreactor with integrated low thermal mass, air-cooled radiant furnace and close-coupled QIC sampling. This item includes the CATLAB-PCS Windows® software and computer control of temperature (ramp/set-point) and flow.</p> <p>Low thermal mass furnace for linear ramp control and set-point regulation to 1000°C: Includes a high temperature quartz sample reactor for operation to 1 bar with high temperature sensors and interface.</p>	303230
	<p><b>CATLAB-PCS Module 2: The QGA 2.0 Mass Spectrometer</b>            A QGA 2.0 bench-top gas analysis system, including Hiden HAL 201 RC mass spectrometer with dual Faraday/Channeltron Electron Multiplier detector. Mass range 200 amu. Includes external scroll pump. QGA 2 &amp; MASsoft Professional software packages included as standard. Includes standard QIC capillary inlet for operation up to 200°C</p>	305110
OPTIONS & ACCESSORIES	Corrosion resistant upgrade	303250
	Corrosion resistant upgrade - additional feed stream	303255
	8 Flow Stream option. Additional 4 channel MFC flow control unit integrated to provide 8 stream gas selection.	303258
	Vapour feed system	303259
	Extended mass range. 300 amu mass range (in place of standard 200 amu mass range)	305113
SPARES KIT	<p><b>Mass spectrometer spares</b>            QGA 2.0 Mass Spectrometer Spares kit including:</p> <ul style="list-style-type: none"> <li>▶ Replacement capillary liner</li> <li>▶ Replacement capillary leak orifice</li> <li>▶ Twin filament</li> </ul>	303148
	<p><b>Microreactor spares</b></p> <p>CATLAB module 1 maintenance kit. Includes replacement 'O' ring seals and tools</p>	3101210
	CATLAB reactor tube. Precision quartz reactor tube assembly with integral gas sampling tube	3101012
	CATLAB sample tube kit. Includes 6 sample tubes, preparation tool, quartz wool and 'O' ring	3101016
	PCS - Additional valve sample loop	303260

# HiddenAPPLICATIONS

Hidden's quadrupole mass spectrometer systems address a broad application range in:

## GAS ANALYSIS

- ▶ dynamic measurement of reaction gas streams
- ▶ catalysis and thermal analysis
- ▶ molecular beam studies
- ▶ dissolved species probes
- ▶ fermentation, environmental and ecological studies



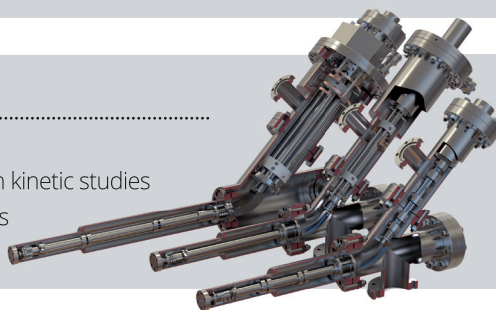
## SURFACE ANALYSIS

- ▶ UHV TPD/TDS
- ▶ ToF qSIMS and SIMS analysers
- ▶ end point detection in ion beam etch
- ▶ elemental imaging – 3D mapping
- ▶ SIMS system with simultaneous dual polarity analysis



## PLASMA DIAGNOSTICS

- ▶ plasma source characterisation
- ▶ etch and deposition process reaction kinetic studies
- ▶ analysis of neutral and radical species



## VACUUM ANALYSIS

- ▶ partial pressure measurement and control of process gases
- ▶ reactive sputter process control
- ▶ vacuum diagnostics
- ▶ vacuum coating process monitoring



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