

## NPS-20

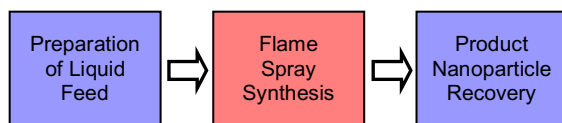
### Benchtop Flame Spray Pyrolysis System for Nanoparticle Synthesis



- ❑ BENCHTOP FLAME SPRAY PYROLYSIS (FSP) UNIT
- ❑ LAB-SCALE SYNTHESIS OF NANOPARTICLES
- ❑ FULLY INTEGRATED TURNKEY SYSTEM
- ❑ RAPID SCREENING OF MATERIAL COMPOSITIONS AND PROCESS CONDITIONS

### FSP process description

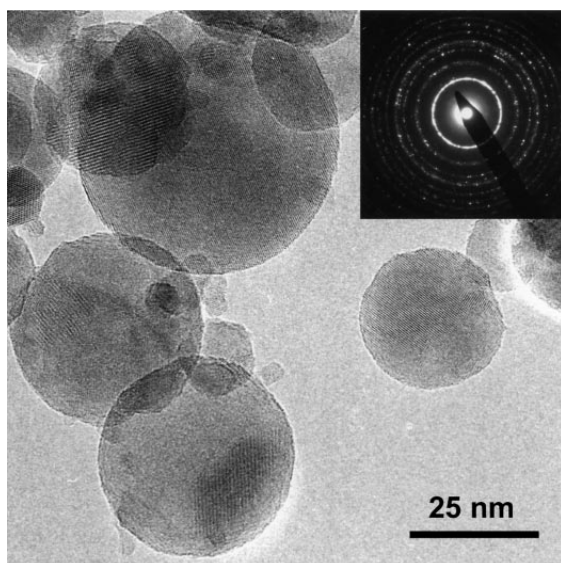
Flame Spray Pyrolysis (FSP) is a versatile and cost-efficient production process for nanoparticles. It relies on the combustion of liquid raw materials containing metal or transition metal compounds at temperatures up to 3000°C. Product nanoparticles are formed within milliseconds and collected as a dry powder on a filter.



The FSP process benefits from an extremely short process chain, enabling the production also of complex nanoparticles in a single step.

### Product Nanopowders

FSP typically produces highly-crystalline oxide nanopowders but phosphates and pure metals have been synthesized as well. A typical size range for primary particles is 5 to 50 nm depending on the process conditions. These primary particles form larger agglomerates.



Examples of product nanopowders include simple metal oxides like  $\text{TiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{ZrO}_2$  as well as complex oxides such as YSZ, CGO, perovskites or spinels. Also, noble metal nanoparticles can be made and deposited onto oxide support particles in the flame. For some compositions, surface-coated or matrix-embedded nanoparticles can be produced.

Applications of FSP nanoparticles include:

- Catalysts
- Battery materials
- Ceramics
- Pigments
- Dental and biomedical materials
- Gas sensors
- Polymer nanocomposites
- Electroceramics
- ...

### Raw materials

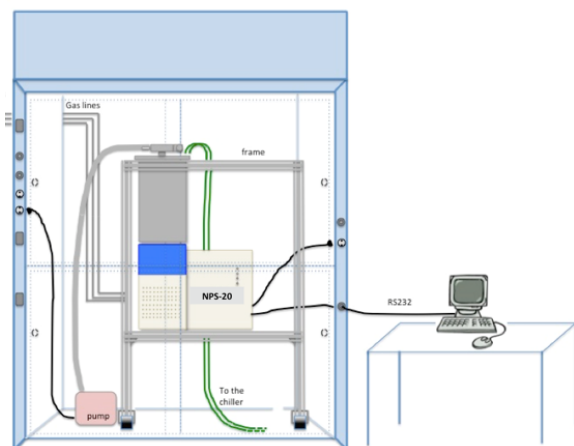
The starting materials for FSP are low-cost metal compounds such as carboxylic acid salts, nitrates, or organometallics. These so-called "precursors" are mixed or dissolved in standard organic solvents (e.g. alcohols, aromatics) that provide the energy for the flame synthesis.

Oxygen is preferably used to disperse the liquid precursor and to complete combustion. A concentric methane-oxygen "supporting" flame ignites the precursor-solvent spray and assures stable combustion. In addition to this, an optional sheath gas (oxygen, air or inert gas) can be employed to envelope the flame and modify the combustion environment.

**NPS-20** is a turnkey bench-top flame spray pyrolysis unit for nanoparticle synthesis at the research and early product development level. NPS-20 has been designed for fast screening of the broad parameter space of material compositions and process conditions available in FSP synthesis to speed up nanomaterial development.



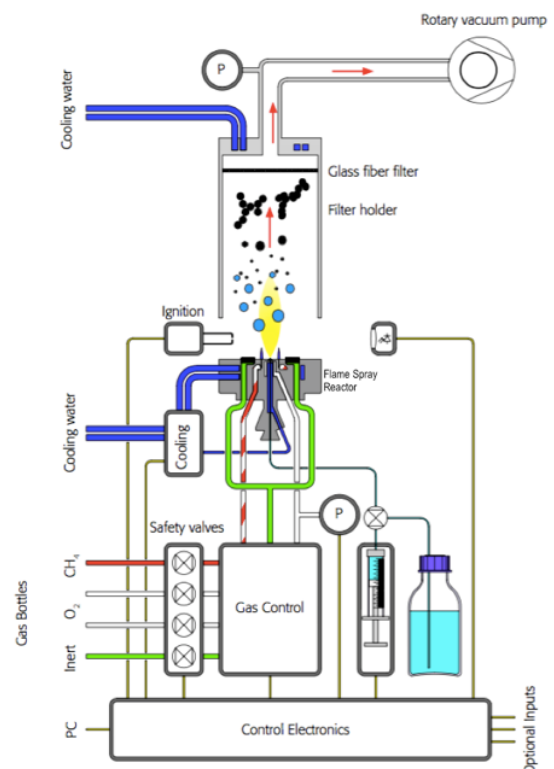
The NPS-20 can be placed on a laboratory bench or is delivered with a mobile rack on request. In any case the system must be placed in a chemical fume hood or similar enclosed and vented area for operation.



### Main features

- Lab-scale flame spray reactor
- Low-pulsation syringe pump for precise feeding of liquid precursor.
- 4 mass flow controllers for delivering the process gases: dispersion oxygen, supporting flame methane and oxygen and optional sheath gas.
- Automatic flame ignition system.
- Flame detector.
- Integrated microprocessor and electronic board for process control.
- Control software and communication via RS 232.
- Glass fibre filter and dry rotary vane vacuum pump for the collection of product powders.
- Pressure and temperature gauges for monitoring the filter status.

### Schematic of the NPS-20



## Technical Specifications

### Mechanical data

Supporting frame	Approx. overall dimensions (L x W x H)	110 x 60 x 160 cm
Pump	Dimensions (L x W x H)	50 x 29 x 25 cm
	Weight	31 kg
NPS-20	Dimensions (L x W x H)	71 x 43 x 53 cm
	Weight	75 kg
Filter holder	Approx. overall dimensions (L x W x H)	30 x 30 x 70 cm
	Weight	15 kg

### Electrical data

Power supply	110 - 230 VAC, 50 - 60 Hz
Power consumption	100 W
Communication	RS-232
Interfaces for external interlocks	3
Process control	PC

### Technical data

Inlet gas connections	4 lines with 1/8" compression fittings
Inlet gas pressure	6 - 9 bar
Supporting flame CH <sub>4</sub> flow rate	0 - 5 L/min
Supporting flame O <sub>2</sub> flow rate	0 - 5 L/min
Dispersion gas type	O <sub>2</sub> , Air
Dispersion gas flow rate	0 - 10 L/min
Sheath gas type	O <sub>2</sub> , Air, inert gas
Sheath gas flow rate	0 - 20 L/min
Precursor flow rate	0 - 15 mL/min
Precursor syringe volume	up to 50 ml
Minimum cooling water flow	0.5 - 2.5 L/min
Maximum cooling water inlet temperature	20 °C
Maximum cooling water pressure	10 bar
Cooling water connection	fittings for ID 8mm OD 10mm

### Pump specifications

Power supply	110 - 220 V @ 50 - 60 Hz	
Nominal displacement	50 Hz	25 m <sup>3</sup> /h
	60 Hz	30 m <sup>3</sup> /h
Ultimate Pressure	120 mbar	
Nominal motor rating 3~ (1~)	50 Hz	0.9 (0.9) kW
	60 Hz	0.9 (0.9) kW
Noise level (DIN 45635)	50 Hz	60 dB(A)
	60 Hz	62 dB(A)

### Filter specifications

Material	Borosilicate glass microfiber
Thickness	350 µm
Porosity	1 µm

### Filter holder specifications

Materials	Stainless steel, anodized aluminum, brass, Viton
Cooling water connections	2 hoses for 8 mm I.D. tubing
Cooling water flow	2 - 10 L/min

