



## RFP-400 Series Raman Probes

Modular, high performance probes for research, QC, and process development applications.

RFP-400 Series Raman probes have been designed to provide the same high optical performance as our RFP-500 Series process Raman probes but in a highly flexible package intended for laboratory and process development applications. The key to the design is a standardized optical head combined with inter-changeable filter modules and objective assemblies.

### RFH-400 PROBE OPTICAL HEAD

This unit includes the fiber-optic terminations, collimating optics, interference filters, and beam combining optics. Its optical design is essentially the same as that of the RFP-500 Series process probes. As a result, calibrations performed with the laboratory probes can often be carried over directly for use in process installations. As in the case of the process probes, the two optical filters are mounted in a single plug-in filter module. This makes it a simple task to switch a given probe for operation with different laser excitation frequencies.

### RFP-410 SIGHT GLASS PROBE

This probe consists of the RFH-400 Optical Head combined with the RFT-10 Non-contact Objective Lens assembly. The standard design provides an optical focus approximately 15 mm from the front of the lens assembly,

allowing the probe to view the sample through a sight glass, the side of a cuvette, or a beaker wall. Other focal distances are available on special order.

### RFP-420 SMALL DIAMETER PROBE

The RFP-420 employs the RFT-20 Small Diameter objective assembly. It is intended for use with small reaction vessels operating at moderate pressures and can tolerate a wide range of chemical conditions<sup>1</sup>.

### RFP-435 EXTRUDER PROBE

This probe mates to the "Dynisco™ compatible" ports available on many extruders. It is designed for operation at temperatures as high as 300 °C and pressures to 300 bar. The RFT-35 Immersion Tip features 316 stainless steel construction, a sapphire window, and the company's proprietary metal window seal design incorporating a Grafoil® seal in a fully welded structure<sup>2</sup>.

### RFP-442 HIGH PERFORMANCE, REDUCED DIAMETER PROBE

By using large internal lightguides, this probe provides an optical signal level almost as high as the RFP-410 Sight Glass. With the objective diameter conveniently reduced to 12.7 mm for the last 200 mm.



### RFP-465 MULTIPASS GAS PHASE RAMAN PROBE

This probe employs our patented multipass design<sup>3</sup>, which provides more than an order of magnitude signal enhancement for transparent vapors. It is still suitable for many installations situations.

### FEATURES:

- Interchangeable objective/immersion assemblies
- Interchangeable filter sets
- 6.35 mm diameter probe tip (RFP-420)
- Compatible with high temperatures and pressures (RFP-435 and 442).
- Compatible with highly aggressive chemistries (RFP-420 through 442)
- Multipass design for enhanced sensitivity (RFP-465)

### REFERENCES:

1. U.S. Patent No. 6,876,801 B2
2. U.S. Patent No. 6,587,195 B1
3. U.S. Patent No. 6,795,177 B2



## PROCESS RAMAN PROBES

In addition to the RFP-400 Series laboratory probes, we manufacture the highly robust RFP-500 Series Process Raman probes (See data sheet PS-RFP-500). These probes feature the company's proprietary welded window seal. They include a sealed conduit termination housing. Optional features include full secondary confinement and provision for retraction from the process line.

## RFP- 400 SERIES OPTIONS AND ACCESSORIES

### INTERCHANGEABLE OBJECTIVE LENS/IMMERSION ASSEMBLIES

A given RFP-400 Series probe can be converted between any of the six basic models by simply installing the appropriate RFT Series Objective Lens Assembly listed in the table below. In some cases, modified

objective assemblies are also available which provide a selection of focus offsets.

### INTERCHANGEABLE FILTER MODULES

Any RFP-400 probe can be switched to operate with a selection of laser excitation frequencies by interchanging RFF-W Series filter Modules, where "W" specifies the excitation frequency in nanometers.

### CUSTOM PROBE LENGTHS

RFP-400 Series probes can be provided in a wide range of lengths. Inquire with us for price and delivery.

### CUSTOM FOCUS OFFSET

The offset of the optical focus from the probe window can be varied to meet particular requirements. Inquire with us for price and availability.

## VESSEL ATTACHMENT

RFP-400 Series Probes can be provided with a variety of means for attachment to a reaction vessel. Inquire with us for price and availability.

## FIBER-OPTIC CABLES

RFP-400 Series probes can be connected to a laser source and to a Raman spectrometer by means of a variety of different fiber-optic cables. For optimum performance, the core diameter of the collection fiber should be at least four times that of the excitation fiber (e.g. 50  $\mu\text{m}$  excitation and 300  $\mu\text{m}$  collection). When the probes are used with a dispersive spectrometer, it is often advantageous to use a bundle to make the transition from the circular pattern characteristic of the probe output to a slit pattern at the spectrometer input slit. (Inquire with us for available configurations.)

## RFP-400 SERIES LABORATORY RAMAN PROBE SPECIFICATIONS:

	RFP-410-W	RFP-420-W	RFP-435-W	RFP-442-W	RFP-465-W
Objective Assembly Included	RFT-10-15	RFT-20-1	RFT-35-0.5	RFT-42-5	RFT-65
Immersible Length:	NA (sight glass)	16 cm	Flush	200 mm	300 mm
Immersion Diam.:	NA (sight glass)	6.35 mm	9.5 mm	12.7 mm	32 mm
Standard Optical Focus Offset:	15 mm	1 mm	0.5 mm	1 - 6 mm <sup>(4)</sup>	NA (multipass)
Max. Sample Temp.:	NA	150 °C	300 °C	200 °C	200 °C
Maximum Pressure:	NA	20 bar	300 bar	100 bar	50 bar
Window Material:	Glass lens	Sapphire	Sapphire	Sapphire	Fused Silica
Window Seal:	NA	PTFE	Grafoil®	PTFE Coated Nickel Alloy	Kalrez® 6375

4. Focus offset set by means of spacers.

Raman Shift Range (all models):	150 – 4000 $\text{cm}^{-1}$
Standard Excitation Wavelengths (all models):	W = 532, 632, or 785 nm
Wetted Metal (all but RFP-410):	316 stainless steel standard, Hastelloy C-276 optional
Excitation Fiber Connector (all models):	FC
Collection Fiber Connector (all models):	SMA