

Immersion Optic for Reaction Monitoring

Raman Products Technical Note

Number 1250

Key Issues

- **Removeable immersible optic for the MR Probe**
- **Two available fixed focal lengths: long (3 mm) for transparent samples and short (0 mm) for opaque samples.**
- **Alloy C276 shaft and sapphire window resist corrosion in harsh environments**

Introduction

The Immersion Optic (IO) for reaction monitoring from Kaiser Optical Systems, Inc., (Kaiser) is designed for *in situ* Raman spectroscopy in a laboratory setting using a Kaiser MR Probe probe head and **RAMANRXN SYSTEMS™** analyzer.

To make the IO easy to use and maintain, the focus is adjusted and locked in at the factory. Because some chemical reactions take place in transparent solutions (such as many Diels–Alder reactions) and others occur in opaque solutions (such as emulsion polymerizations), the IO is available in either short (0 mm) or long (3 mm) fixed focal lengths that require no manual adjustment or optimization. Long-focal-length optics are only suited for analyzing transparent samples. Placing the focal point slightly away from the optic window allows the greatest sampling volume and highest collected Raman intensity because it maximizes the effective focal cylinder (Figures 2 and 3). In contrast, short-focal-length optics are ideal for opaque samples or solutions. The focal point is set adjacent to the sapphire window to minimize specular reflection and diffuse scatter of the incident laser by the sample, particulate in the sample, or Raman scatter loss by material outside the focal cylinder. The desired focal length is determined by the application although for most practical purpose the short focus optic is the preferred choice as its geometry is more universally applicable.



Figure 1. IO attached to a MR Probe probe head.

The IO is available in a variety of lengths and two different diameters to fit nearly any reaction vessel.

Lengths for half-inch-diameter shafts range from 3.0 inches to 18.0 inches. Also available is a quarter-inch shaft, with a length of six inches, for small reaction vessels.

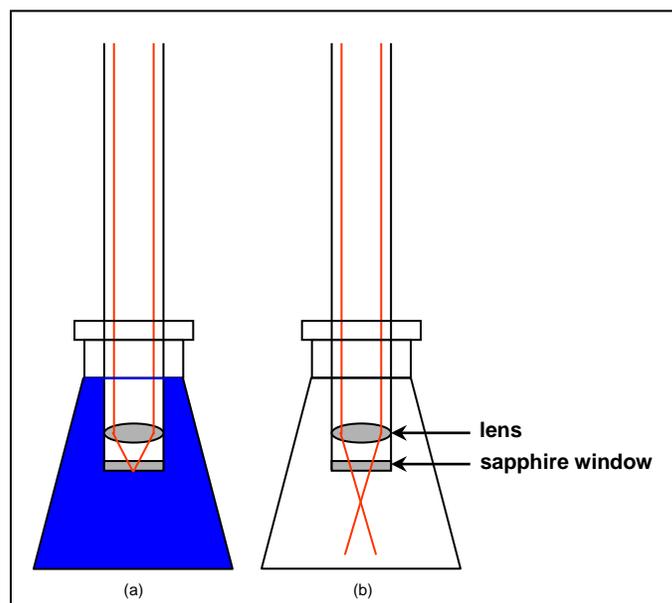


Figure 2. (a) A short-collection-zone optic used with an opaque sample; (b) a long-collection-zone optic used with a transparent sample. (Note: This diagram is not to scale.)

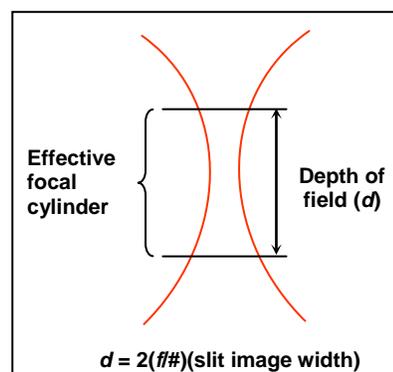


Figure 3. Diagram of the effective focal cylinder and depth of field of an incident laser (not to scale).

Table 1. Specifications for Half-Inch IO

Immersible shaft length	3.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, or 18.0 inches
Temperature range	-30 to 450 °C
Temperature ramp	≤ 6 °C/min
Pressure range	≤ 3000 psi
Lens <i>f</i> /number	<i>f</i> /2
Working distance (fixed)	Short: 0 mm; long: 3 mm
Construction materials:	Shaft: Alloy C276 Window: sapphire, proprietary compression fit non-brazed design
Transmittance	VIS or NIR

Table 2. Specifications for Quarter-Inch IO

Immersible shaft length	6.0 inches
Temperature range	-30 to 450 °C
Temperature ramp	≤ 6 °C/min
Pressure range	≤ 3000 psi
Lens <i>f</i> /number	<i>f</i> /2
Working distance (fixed)	Short: 0 mm; long: 3 mm
Construction materials:	Shaft: Alloy C276 Window: sapphire, proprietary compression fit non-brazed design
Transmittance	VIS or NIR

Acid Resistance

Acidic media are generally challenging to analyze with traditional brazed window technology. The Kaiser IO has been shown to be resistant to long-term exposure to HCl.

Available Shafts

The half-inch IO is available in the following lengths (in inches): 3.0, 4.0, 6.0, 8.0, 10.0, 12.0, 14.0, 16.0, 18.0.

All of these shaft lengths are available with either short or long focal length and optimized for either visible or NIR operation.

The quarter-inch IO is standardly available with a length of 6.0 inches. Both short and long focal length optics are available.

**Figure 4.** View of the cap of the MR Probe probe head that is used to secure the immersion optic.

Tip Assembly

All Kaiser's IOs feature a unique shaped sapphire window to avoid probe fouling when immersed in "sticky" media.

**Figure 5.** View of the tip of an IO. Standard Kaiser shaped tip (left) and traditional flat tip (right).

Summary

In situ monitoring is a powerful tool for both research and analytical scientists. The use of a IO with a MR Probe probe head and a **RAMANRXN SYSTEMS** analyzer allows Raman spectra to be collected *in situ* and simultaneously from 175 to 4325 cm^{-1} (532-nm excitation). Because there are no moving parts, the IO is optimized and in focus every time.