Non-Contact Optics

Raman Products Technical Note *Number 1251*

Key Issues

- ***Non-contact analysis of delicate or corrosive samples***
- ***Various working distances and f/numbers available for disparate applications***

Introduction

Raman spectroscopy is typically carried out by exciting a sample with laser radiation, collecting the scattered photons, and plotting a spectrum of the inelastic (Raman) scatter. In most current Raman systems, the scattered photons are collected at 180°, which means that the same probe is used for both excitation and collection. Because it is a scattering, rather than absorption, technique, Raman can usually be performed with no special preparation of the sample. For many systems, especially solids, this means that there is no need to even come into contact with the sample during the analysis. Because Raman normally uses incident radiation in the visible (VIS) or near-infrared (NIR) region, the laser can be focused through many polymers and glasses used for containers or sight glasses in process streams to sample the material within (Figure 2).

Figure 1. Three Kaiser non-contact optics.

Kaiser Optical Systems, Inc., (Kaiser) has a complete line of non-contact optics compatible with the MR Probe probe head used with the ***RamanRxn Systems™*** suite of analyzers. They are designed for use in environments that could be damaging to optics or where sample contamination could be an issue. The working distances range from 0.3 inches to 17 inches, allowing them to be used in a variety of applications.

Each optic is optimized for either visible or NIR incident radiation.

Table 1 contains the working distances and *f*/numbers of all Kaiser's non-contact optics. Long working distances are ideal for processes that require the laser to be focused through thick sight glasses or for the probe to monitor a moving solid such as a polymer film.

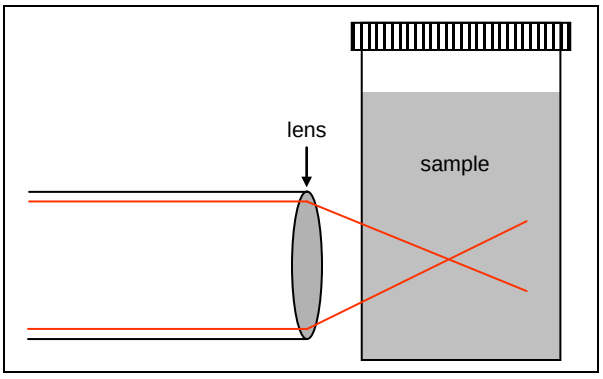

Figure 2. Schematic drawing of a non-contact optic with the incident laser focused through the wall of a sample container.

Table 1. Specifications of Kaiser's Non-Contact Optics

Optic	Working distance	*f*/number
NCO-0.4-NIR	0.4 in. 1 cm	*f*/2.0
NCO-0.5-VIS	0.5 in. 1.25 cm	*f*/2.0
NCO-1.3-VIS/NIR	1.3 in. 3.3 cm	*f*/1.8
NCO-2.5-VIS	2.5 in. 6.4 cm	*f*/3.0
NCO-3.0-NIR	3.0 in. 7.5 cm	*f*/3.0
NCO-5.5-VIS/NIR	5.5 in. 14 cm	*f*/3.0
NCO-17-VIS/NIR	17 in. 43 cm	*f*/10.0

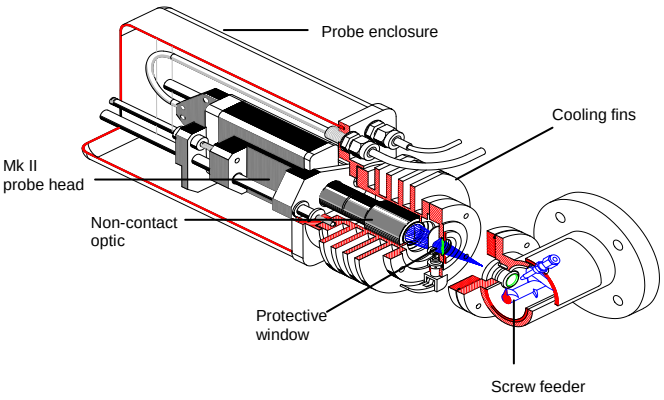

Figure 3. Cutaway view of probe and sample interface for on-line TiO_2 process monitoring.

Figure 4. The Raman sampling interface in place on a TiO_2 process line.

Monitoring TiO_2 Production

Figure 3 shows a cutaway view of the apparatus used in the on-line manufacturing of TiO_2. In this process, a small portion of the TiO_2 is diverted in a screw feeder and analyzed with a probe head and a non-contact optic enclosed behind a window in a special protective enclosure (the black canister and red cooling fins seen in Figure 4). The environment on the TiO_2 process line is extremely dusty and abrasive and would quickly damage the sampling apparatus if in direct contact.

On-line Monitoring of Polymer Films

Raman analyzers with non-contact optics have also found application in monitoring of moving polymer film lines. Raman allows films to be analyzed intact and non-destructively. This method also allows the film to be monitored without modifying the film production equipment; the probe can simply be suspended above the moving film, as in Figure 4.

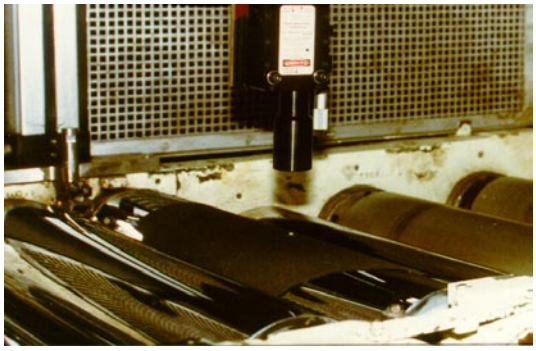

Figure 4. Monitoring a moving polymer film line.

Applications in Forensic Analysis

Non-contact optics are especially valuable in forensic science for two reasons. First, contact with the sample often introduces contamination that could be detrimental to its use as evidence in court. Second, many forensic samples, such as drugs of abuse and explosive residues, are toxic to the handler. Many drugs of abuse are stored and transported in clear plastic (low-density polyethylene, LDPE) bags. Because these bags are transparent to the visible and NIR radiation usually used for excitation in Raman, the sample can be analyzed by focusing the incident laser at a point within the bag.

Semiconductors

Semiconductor materials are produced in a scrupulously clean environment to ensure minimum contamination from outside sources. With a Raman fiber optic probe head and a non-contact optic, applications as diverse as silicon temperature measurements, silicon stress/strain and cleaning solution concentration can be performed.

Summary

The above applications illustrate the broad utility of non-contact optics in Raman spectroscopy. They can be used to analyze materials that need to be protected from contamination and to analyze potentially destructive or corrosive systems, even operating behind glass windows.

Acknowledgements: TiO_2 applications information provided by ICI, Ltd.

Reference:

Slater, J.B.; Tedesco, J.M.; Fairchild, R.C.; and Lewis, I.R. Raman Spectroscopy and Its Adaptation to the Industrial Environment. In *Handbook of Raman Spectroscopy;* Lewis, I.R.; Edwards, H.G.M., Eds. Marcel Dekker: New York, 2001; pp. 41–144.