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Application News

Infrared Raman Microscope AIRsight™

Excitation Laser Selection in the AIRsight Infrared Raman Microscope —An Evaluation of UV-Degraded Plastics—

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User Benefits

- The AIRsight infrared Raman microscope comes with two excitation lasers that can be selected to best suit samples.
- Its 785 nm laser enables effective analysis of samples affected by fluorescence.
- A photo-bleaching time can be set to reduce the influence of fluorescence.

■ Introduction

In Raman spectroscopy, the scattering intensity is inversely proportional to the fourth power of the excitation laser wavelength (Rayleigh's scattering law). Therefore, the intensity of the Raman signal depends on the wavelength of the laser. Shorter wavelengths are typically used to obtain stronger signal intensities, but that can also result in fluorescence. Fluorescence emitted by a sample when absorbing incident UV-visible light from a short wavelength laser can obscure weaker Raman signals. In such cases, longer wavelength lasers that induce less fluorescence can reduce the influence of fluorescence. The AIRsight infrared Raman microscope system (see Fig. 1) is equipped with 532 nm and 785 nm lasers as standard, allowing the user to select the laser wavelength that best suits a sample.

This article presents the results of a measurement that used the two lasers in AIRsight to evaluate UV-degraded plastics. When evaluated by FTIR spectroscopy, the spectral shape of plastics is known to change when they are damaged by UV irradiation. More information on this topic can be found in Application News 01-00001.

Fig. 1 IRTracer™-100 (Left) and AIRsight (Right)

■ Measurement of UV-Degraded Plastics

The plastics used in this measurement were nylon (polyamide: PA), polyethylene (PE), and acrylonitrile butadiene styrene (ABS). Fig. 2 shows the measured samples before they were exposed to UV irradiation (unirradiated) and after UV irradiation (irradiated).

Raman spectroscopy was performed using the conditions shown below.

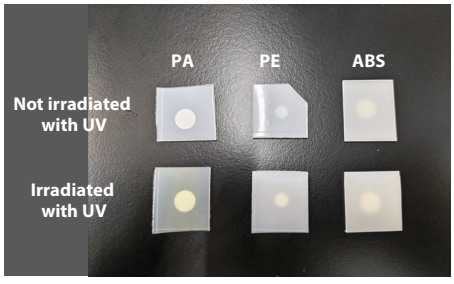

Fig. 2 Photograph of Samples

Table 1 Measurement Conditions

Instruments:	IRTracer-100, AIRsight
Accumulation:	10
Exposure Time:	5 sec
Objective Lens:	50x
Excitation Wavelengths:	532 nm, 785 nm
Detector:	CCD

Results from Measurement of PA

Fig. 3 shows the Raman spectra of the unirradiated PA sample with the 532 nm and 785 nm lasers. Although signal peaks were still discernible (the black line in Fig. 3) with the 532 nm laser, it produced a somewhat raised baseline due to the influence of fluorescence. In contrast, the spectrum obtained using the 785 nm laser (the red line in Fig. 3) did not have a raised baseline. As a side note, a broader range of wavenumbers could be measured using the 532 nm laser compared to the 785 nm laser, which enabled the detection of hydroxyl (-OH), imino (-NH), and amino groups (-NH_2) that produce signals in the 4000 to 3000 cm^{-1} wavenumber range.

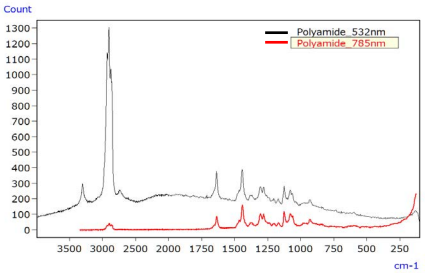

Fig. 3 Raman Spectra of Unirradiated PA

Fig. 4 shows the Raman spectra of the irradiated PA sample with the 532 nm (black line) and 785 nm (red line) lasers. The 532 nm laser produced a very raised baseline due to the influence of fluorescence, and the signal peaks were difficult to discern. In contrast, the spectrum from the 785 nm laser showed almost no influence from fluorescence, and it had easily discernible signal peaks.

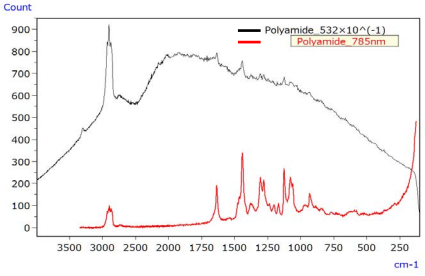

Fig. 4 Raman Spectra of UV Irradiated PA
(532 nm data divided by 10)

Results from Measurement of PE

Fig. 5 shows the Raman spectra of the unirradiated PE sample with the 532 nm and 785 nm lasers. Both lasers produced spectrums with no raised baselines or discernible signal peaks.

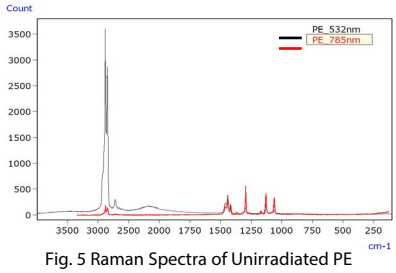

Fig. 5 Raman Spectra of Unirradiated PE

Fig. 6 shows the Raman spectra of the irradiated PE sample with the 532 nm and 785 nm lasers. Both lasers produced spectrums with raised baselines due to the influence of fluorescence. In such cases, photo-bleaching can be used to reduce fluorescence.

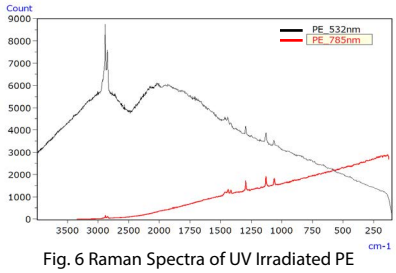

Fig. 6 Raman Spectra of UV Irradiated PE

Fig. 7 shows the Raman spectra from Fig. 6 alongside Raman spectra recorded after performing the same analysis with a photo-bleaching* time of 180 seconds. This demonstrates how the influence of fluorescence can be mitigated by setting a photo-bleaching time.

* The sample was irradiated for the set photo-bleaching time before signal measurements began.

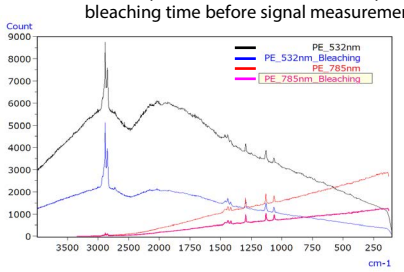

Fig. 7 Raman Spectra of UV Irradiated PE (Photo-Bleaching: 180 Seconds)

Results from Measurement of ABS

Fig. 8 shows the Raman spectra of the unirradiated ABS sample with the 532 nm and 785 nm lasers. The Raman spectrum obtained from the 532 nm laser was significantly influence by fluorescence, and the signal peaks were difficult to discern.

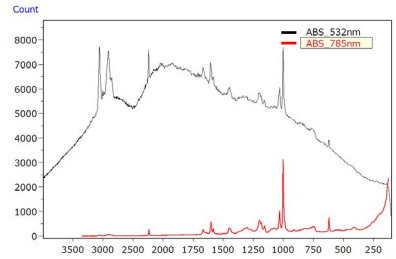

Fig. 8 Raman Spectra of Unirradiated ABS

Fig. 9 shows the Raman spectra of the irradiated ABS sample with the 532 nm and 785 nm lasers. As with PE, the influence of fluorescence was reduced by setting a photo-bleaching time.

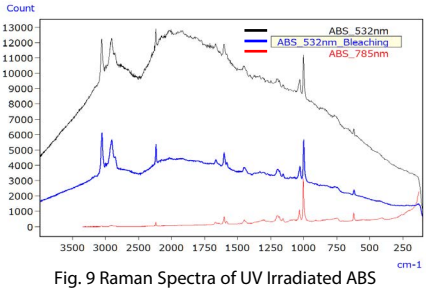

Fig. 9 Raman Spectra of UV Irradiated ABS

Finally, because the ABS sample emitted fluorescence during excitation at 532 nm whether irradiated or not, a spectrofluorometer (the Shimadzu RF-6000) was used to examine the fluorescence spectra of the samples (see Fig. 10). Fluorescence spectroscopy was performed using the measurement conditions shown in Table 2.

Table 2 Measurement Conditions

Instrument:	RF-6000
Excitation Wavelength:	532 nm/380 nm
Fluorescence Wavelength Range:	545 to 700 nm / 400 to 700 nm
Data Interval:	1.0 nm
Scanning Speed:	600 nm/min
Bandwidth:	Ex 3.0 nm, Em 5.0 nm
Sensitivity:	Low

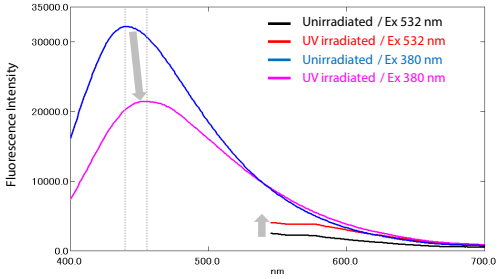

Fig. 10 Fluorescence Spectra of ABS

Although the data are not presented here, 3D spectral measurement showed that ABS emitted high-intensity fluorescence during excitation with UV light (380 nm). The fluorescence spectral results were also consistent with the Raman data, with ABS emitting fluorescence during excitation at 532 nm. In addition, the fluorescence spectral data for UV-degraded ABS showed that the fluorescence peak intensity was reduced; the fluorescence peak was shifted towards longer wavelengths compared to unirradiated ABS at an excitation wavelength of 380 nm; and the fluorescence peak intensity was increased compared to unirradiated ABS at an excitation wavelength of 532 nm.

■ Conclusion

This Application News measured three plastics using the 532 nm and 785 nm lasers of the AIRsight infrared Raman microscope. The measurement showed that the influence of fluorescence on signal data was reduced when using the 785 nm laser compared to the 532 nm laser and that it could also be reduced by setting a photo-bleaching time.

AIRsight is equipped with two lasers as standard, allowing each laser to be used as best suited to the sample and the targeted wavenumber range.

01-00586-EN First Edition: Sep. 2023

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