Application Note

Materials Testing & Research

Shielding Your Snacks: The Crucial Role of UV-Blocking Food Packaging

Food packaging analysis using the Agilent Cary 60 UV-Vis with diffuse reflectance accessory

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Abstract

The quality and safety of packaging materials is a major consideration for the food industry to preserve the integrity of food products while providing a pleasing aesthetic look for potential customers. Plastic bottles, films, and containers are commonly used for packaging, however, transparency to ultraviolet (UV) light can pose a risk to light-sensitive foods and liquids. Quality control testing of these packaging materials is therefore essential for the food industry. It is also often important to measure the transparency to visible light of these containers to fulfill aesthetic requirements. In this application note, the Agilent Cary 60 UV-Vis spectrophotometer fitted with the internal diffuse reflectance accessory (DRA), was used to measure the total transmission of UV and visible light through several types of plastic food packaging materials.

Introduction

An important consideration in the design of packaging for perishable food and beverages is the blocking of ultraviolet (UV) light in the 200 to 400 nm range. UV light can reduce the shelf-life of foodstuffs through accelerated degradation by photo-oxidation or light-catalyzed reactions. In addition to blocking light in the UV range, some packaging is required to have a certain level of transparency in the visible range (400 to 900 nm) for aesthetic reasons. Consequently, measuring the transmittance of light in the UV-visible spectrum (200 to 900 nm) is an essential step in designing and testing effective UV barrier materials for food packaging.[1]

In this application note an Agilent Cary 60 UV-Vis spectrophotometer (Figure 1) was fitted with a Cary 60 UV-Vis DRA (Figure 2) and used to measure the transmission of light through various food packaging types. This internal DRA is an integrating sphere that is fitted within the sample compartment of the Cary 60 UV-Vis spectrophotometer and allows for the measurement of diffuse transmission or reflectance of solid, liquid, and powder samples. Solid food packaging samples are often frosted or textured in a way that results in diffuse transmission of light. Scattering and diffusing samples can be challenging to measure in a standard transmission sample compartment as some of the diffused light can be directed away from the detector and not be collected, leading to inaccurate results. For these samples, the use of DRAs is recommended. An integrating sphere collects and measures all transmitted and forward scattered light from the sample making it an essential tool to gather accurate answers in this application. The solid sample holder of the DRA is simple to use and provides consistent measurements of the UV-Vis transmission spectrum of these different plastic samples.

Figure 1. The Agilent Cary 60 UV-Vis spectrophotometer.

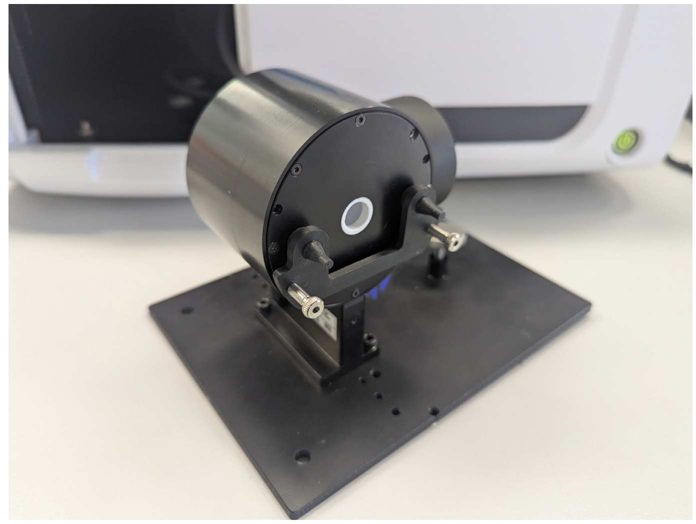

Figure 2. Internal DRA for the Agilent Cary 60 UV-Vis spectrophotometer with solid film sample holder.

Experimental

Samples of 4 × 4 cm were cut from four different packaging types, cleaned with distilled water, and gently wiped with laboratory tissues to remove fingerprints and residues. The samples chosen were a candied ginger packet, gummy bear wrapper, sesame seed bar wrapper, rice package, and milk and water bottles. These were then mounted to the internal DRA in front of the transmission port using the solid film sample mounting clip and an insert that reduced the aperture size to 6 mm. Figure 3 shows the total transmission (= diffuse and specular transmission) of light in the DRA with the sample in this position. The reflection port was covered with a PTFE-coated insert for these experiments.

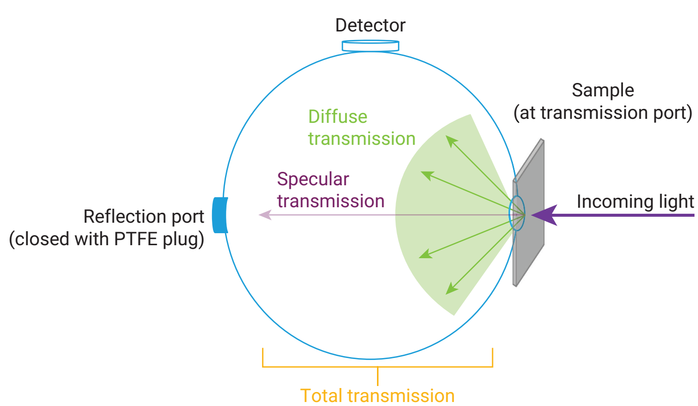

Figure 3. Diagram of total transmission (= specular and diffuse transmission) in the DRA for the Agilent Cary 60 UV-Vis spectrophotometer.

A 100% transmittance baseline was collected with no sample in the transmission port, and this was used for all subsequent sample measurements. UV-Vis percentage transmittance (%T) spectra were collected using the Cary 60 UV-Vis spectrophotometer with internal DRA and the scan application of the Agilent Cary WinUV software with the following measuring parameters:

- Spectral range of 200 to 900 nm
- 0.1 sec averaging time
- 1 nm data interval

Five repeat measurements were taken by repositioning and rotating each sample between each measurement to ensure that any variations across the sample surface did not have a significant impact on the results.

Results and discussion

The %T spectra of the four samples were collected and are displayed in Figure 4.

The ginger and rice packages showed a sharp absorption edge at 330 nm and the gummy bear and sesame wrappers showed one at 305 nm where the %T falls from 85 to 95% to almost 0%. This indicates that the packaging exhibits high transparency in the visible and UVA wavelength range (315 to 900 nm) but absorbs a large amount of UVB light (280 to 315 nm). The milk bottle exhibits a lower transparency in the visible region and is at least semitransparent to UV light.

Table 1 shows the mean %T of the samples over the UV (200 to 400 nm) and visible (400 to 900 nm) wavelength ranges. The average standard deviation of %T in these two wavelength ranges was also calculated by taking the standard deviation of five repeat measurements at each measured wavelength in the continuum and averaging that over the two indicated wavelength ranges. Each repeat measurement was performed by rotating and repositioning the sample to reveal inhomogeneity across the sample. The average standard deviation was not more than 0.6%T indicating that the samples and the Cary 60 UV-Vis with the internal DRA can produce accurate measurements of the UV and visible transmittance of different plastics .

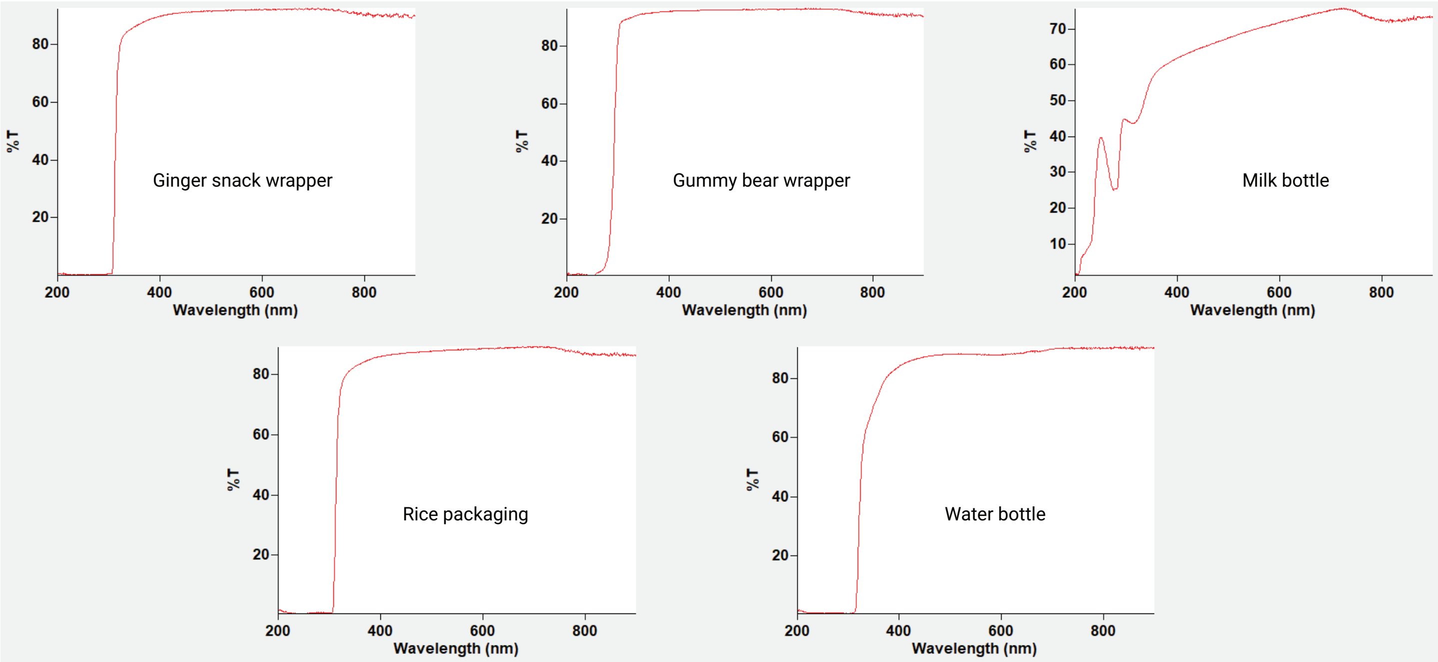

Figure 4. UV-Vis transmission (%T) spectra of different packaging types collected using the Agilent Cary 60 UV-Vis spectrophotometer DRA in total transmission mode.

Table 1. Average %T of various plastic packaging samples over the UV and visible wavelength range with standard deviation averaged over those ranges.

Sample	200 to 400 nm %T (Mean)	400 to 900 nm %T (Mean)	200 to 400 nm Average Standard Deviation %T	400 to 900 nm Average Standard Deviation %T
Candied Ginger Package	37.8	91.4	0.1	0.2
Rice Package	36.1	87.6	0.3	0.5
Gummy Bear Wrapper	50.0	92.2	0.2	0.2
Milk Bottle	38.2	70.6	0.5	0.4
Water Bottle	28.9	88.9	0.6	0.3

Conclusion

The Agilent Cary 60 UV-Vis spectrophotometer with internal DRA was used to measure the total transmission of food packaging materials in the UV-Vis wavelength range. The simple workflow allows for the fast analysis of the UV protection and visible esthetics of a range of solid samples with great confidence. This easy-to-use solution helps users and producers of food packaging products to quickly and reliably check that the food packaging meets their requirements and is fit for the intended purpose.

Reference

1. Roy, S.; Ramakrishnan, R.; Goksen, G.; Sunita Singh, Łopusiewicz, L. Recent Progress on UV-light Barrier Food Packaging Films – A Systematic Review, *Innovative Food Sci. Emerging Technol.* **2024**, *91*, 103550. DOI: 10.1016/j.ifset.2023.103550

Further information

- Agilent Cary 60 UV-Vis Spectrophotometer
- Cary 60 UV-Vis Diffuse Reflectance Accessory
- UV-Vis Applications Guide
- Cary WinUV Software for UV-Vis Applications
- UV-Vis Spectroscopy and Spectrophotometry FAQs

www.agilent.com/chem/cary-60-uv-vis

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