Simple, automated measurements of the photocatalytic properties of colorimetric species using the Agilent Cary 60 UV-Vis spectrophotometer with fiber optics

Application Note

Chemicals

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Summary

The Agilent Cary 60 UV-Vis spectrophotometer is the new, improved successor to the award-winning Cary 50 UV-Vis. In this short review, this instrument platform was evaluated for its potential to measure small (40 µL) samples of methylene blue *in situ* during exposure to high-intensity UV irradiation. Methylene blue is combined with other compounds used in a variety of applications, including use in cosmetics and sun screen products and environmental remediation in contaminated air and polluted water.

Introduction

By virtue of its unique optical design, we have previously demonstrated that the Cary 60 UV-Vis has no measureable effect on photobleaching of the polyaromatic hydrocarbon probe methylene blue[1], which has been shown to be particularly susceptible to photobleaching during continuous readings in UV-Vis instruments from other manufacturers[2]. In the present study, we extend our observations to applications in which photobleaching is desirable, induced by an external, high-intensity UV lamp. This is of significant benefit when analyzing the photochemical properties of electron-quenching compounds, such as methylene blue, that can have protective properties against a broad range of ailments associated with UV exposure, including cancer[3].

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Using the fiber optics microprobe accessory with the Cary 60, the purpose of this study was to develop an automated method of analysis to study the induced photobleaching of samples *in situ*, as opposed to conventional approaches that require sampling be made manually using a cuvette resulting in less accurate results and significant increase in time per analysis (Wang et al[4]).

In the present study, we use fiber optics in aqueous samples at 20 °C under conditions of normal laboratory fluorescent ambient lighting. This approach allows users to take the instrument to the sample, rather than the conventional approach in spectroscopy in which the sample is presented to the instrument. The unique optical configuration of the Cary 60 makes this possible mainly by virtue of the high-intensity xenon flash lamp combined with the latest electronics, enabling the system to effectively monitor small changes in absorbance without any effect of ambient light. Key benefits of this approach are discussed further in this document.

Apparatus and materials

Part Number	Description
G6860AA	Cary 60 UV-Vis with WinUV software and PC
7910035600	Fiber optic microprobe
G6866A	Fiber optic probe coupler

Methods and results

The Cary 60 instrument platform was fitted with the fiber optics coupler and microprobe as shown in Figure 1. Baseline readings were taken using purified water.

A solution of methylene blue (12.5 ppm, 60 mL) was prepared by diluting stock solution (400 ppm) in purified water. Incrementally, small aliquots of a solution of titanium (0.50 g/L, 200 µL) were added in order to assess and evaluate the effects of the photodegradation rate of methylene blue against time in the presence of titanium. Samples were placed in a Class 2 safety cabinet where they were irradiated with high-intensity UV light to induce photochemical reaction, being stirred continuously during the analysis, and the absorbance measured at 20 °C using a fiber optic microprobe.

Figure 1. The Cary 60 UV-Vis fitted with the fiber optics microprobe accessory provides a simple mechanism to measure a sample *in situ* and remote to the instrument

Using the Scanning Kinetics application module in the Cary WinUV software package, scans were taken at 2-min intervals from 400–800 nm over a period of 20 min. The effect of the high-intensity UV lamp on the photokinetic properties of the methylene blue solution was assessed in terms of peak height and blue-shifting of the spectra (Figure 2).

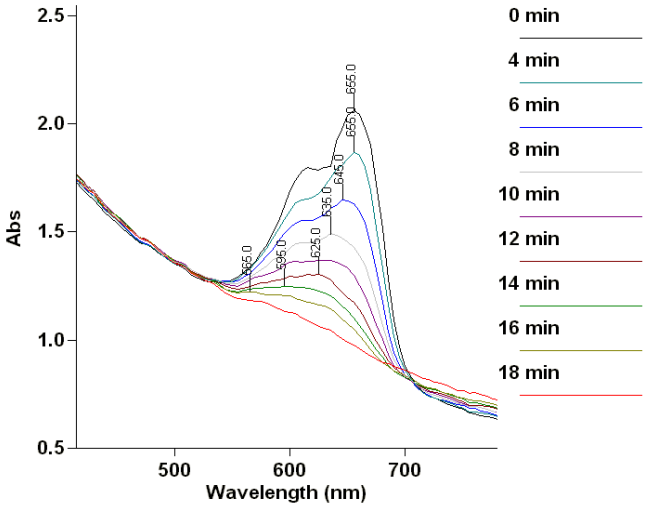

Figure 2. Scanning kinetics using fiber optics *in situ* of methylene blue under the exposure of a high-intensity UV lamp (Oriell 500 W Hg(Xe) lamp) over a period of 20 minutes within the range 400 to 800 nm. Labels refect maximum absorbance wavelengths

Discussion

Results in Figure 2 show significant photobleaching of the methylene blue solution and a blue-shift of the maximum absorbance peak at 655 nm over the 20-min period.

These results are comparable with those taken in a cuvette at room temperature, which conventionally demands transfer of aliquots of the sample to an instrument remote from the reaction chamber. This approach results in inaccurate data, particularly so when dealing with photosensitive samples such as methylene blue[2].

Conclusion

Results discussed above demonstrate that the Agilent Cary 60 instrument fitted with the fiber optics microprobe accessory provides a simple, cost-effective, rapid and versatile system for the automated measurement of photocatalytic reactions *in situ*. As far as the authors are aware, this is the first time this approach (i.e., with fiber optics) has been successfully accomplished.

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