

Thin Film Analysis by Grazing Angle ATR Spectroscopy

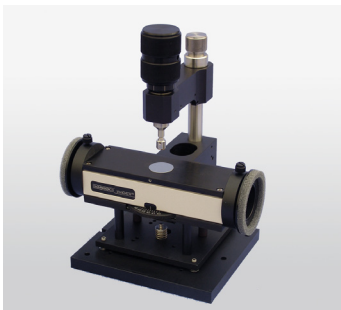


Figure 1. The VariATR grazing angle ATR accessory.

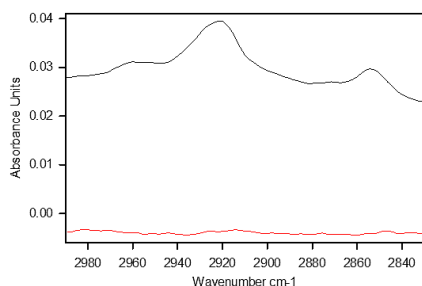


Figure 2. The ATR spectrum of a thin film on a gold substrate (black). The Grazing Angle Reflectance Spectrum is shown in red for reference.

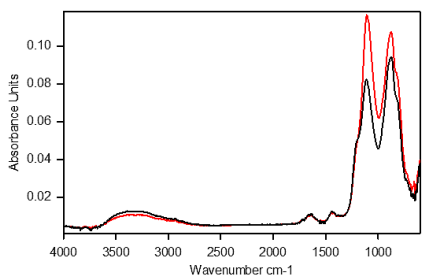


Figure 3. The ATR Spectra of Si coated with a 50Å thickness (black) and 90Å thickness (red).

INTRODUCTION

Thin films on high refractive index substrates like silicon and gold have always been tricky to examine by infrared spectroscopy. Silicon substrates lend themselves to analysis by transmission, but the absorbances due to the thin films deposited thereon are weak, at best, and the transparent nature of the substrate makes these samples difficult to analyze by other means. Reflective substrates like gold are frequently examined by grazing angle specular reflectance. This method is also plagued by weak bands and data is generally collected over a long period of time to obtain well resolved infrared bands.

A new technique has recently been developed for examining these types of samples—grazing angle Ge-ATR.

EXPERIMENTAL

The ATR measurements were recorded using Harrick Scientific's VariATR grazing angle ATR accessory on an infrared spectrometer with a DTGS detector. The spectra were collected at 8 cm^{-1} resolution with 16 scans signal averaged and an incident angle of 65° .

RESULTS AND DISCUSSION

The ATR spectrum of thin organic film coated on a metallic substrate is shown in Figure 2. The grazing angle specular reflectance is shown here for reference. Note that the peak intensities are nearly an order of magnitude greater than those recorded by the traditional grazing angle method.

Figure 3 shows the ATR spectra of two silicon wafers coated with different thicknesses of the same material. For this particular coating, the peaks are readily resolved for coatings as thin as 50Å and could even be resolved for 10Å thick coatings. This highly sensitive method is predicted to be 1000 times more sensitive than the equivalent transmission measurement.

Grazing angle ATR is an exciting new method for the analysis of thin films on high refractive index substrates.

REFERENCES

1. M. Milosevic, S. L. Berets, and A. Fadeev, "Analysis of Monolayers on Si by Single Reflection ATR", in submission to *Applied Spectroscopy*.
2. Josef Michl, Mary E. Mulcahy, M. Milosevic, and S. L. Berets, "Single Reflection pseudo-ATR of Organic Monolayers on Metal Substrates", in preparation.
3. J.E. Olsen and F. Shimura, *Appl. Phys. Lett.*, **53**, 1934 (1988).
4. J.E. Olsen and F. Shimura, *J. Appl. Phys.*, **66**, 1353 (1989).