To those with an interest in photography, polarization will be familiar as a method for eliminating specular reflections from the surface of water or glass, bringing out subsurface details in stunning clarity. However, in industrial applications polarisation is often neglected.

Polarized light is useful because it enables selective measurement of samples that either alter the polarization state of the incident beam, or preferentially absorb one polarization of light over another; the former is the basis of ellipsometry and polarimetry techniques (among others), the latter is the basis of many infrared spectroscopic measurements with polarized light.

Parallel & perpendicular polarization

Linearly polarized light has its electric field confined to a plane. When this vector is aligned with the plane of incidence (the plane containing the incident, reflected, and transmitted rays at an interface) the light is said to be parallel, or p-polarized; when the vector is normal to the plane of incidence, the light is said to be perpendicular, or s-polarized.

Anisotropy within samples can easily be explored by measuring alternately with parallel and perpendicularly polarized light and comparing the responses.

Crossed polarizers

Two polarizers with their grids oriented at 90° to one another are said to be ‘crossed’.

Absorption of a polarized beam is maximized when its electric field is parallel to the electric dipoles in the sample.

For a sample material where all molecular dipoles are oriented in the same direction, varying the polarization angle will yield minimum and maximum intensities for a given absorbance. This gives information on the orientation of those molecules with respect to the beam. It is the key to many applications of polarizers.

Thin film measurement

A common measurement requiring polarized light is that of thin-films on reflective substrates with infrared reflection absorbance spectroscopy (IRRAS). Molecular dipoles oriented normal to the substrate surface will strongly absorb p-polarized light at grazing (>80˚) angles of incidence [1].

Certain variable angle specular reflectance accessories, such as the Specac Monolayer/Grazing Angle Reflectance accessory, can provide this measurement.

Dichroic measurements of surface immobilized proteins

In reflectance measurements such as attenuated total reflectance and specular reflectance, molecular transition dipoles oriented parallel to the plane of incidence absorb parallel polarized light more strongly than when perpendicularly polarized. The dichroic difference spectrum, can be used to measure the relative orientation of the dipoles to the surface [2].
Polarization spectroscopy of gases

Polarization spectroscopy uses polarizers in the crossed configuration described above: a gas placed between the polarizers is excited by a polarized pump laser frequency, which induces detectable polarization changes in a probe beam passing through the sample [3].

Terahertz Time-Domain Spectroscopy

Light sources used for terahertz time-domain spectroscopy are usually linearly polarized: the detectors, too, are sensitive to the polarization [4]. Free standing wire grid polarizers may be used for the region below 0.5 THz [5].

Infrared Ellipsometry

Ellipsometry is a technique that uses a pair of polarizers to measure the change in polarization state of a reflected or transmitted beam after interaction with thin surface layers.

Specac’s Wire Grid Polarizers

Specac manufacture two types of wire grid polarizer covering the entire mid-infrared and far-infrared and terahertz regions of the spectrum.

Holographic wire grid polarizers for the mid-infrared are directly compatible with our high-end ATR and specular reflectance accessories, while our free standing wire grid polarizers are suitable for Terahertz spectroscopy.

References


Get in touch: Collaborate with Specac

Are you working in a field that uses, or could use, our FTIR, polarizer, heated platen or hydraulic pressing equipment?

We are offering end-users the chance to:

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To promote your research with us, please contact collab@specac.co.uk with a simple brief, detailing:

- what your work involves
- what equipment you currently/can use
- why your work is important