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POLARIZED LIGHT MICROSCOPY (PLM)

Polarized light microscopy (PLM) is a collection of visible light imaging techniques, which have as a common feature the placement of polarizing filters in the optical path of a light microscope. These filters enhance observation and measurement of various optical phenomena, including indices of refraction, optical sign, sign of elongation, dispersion, birefringence, color, texture, and pleochroism.

PLM Applications Include:

1. Materials Evaluation

Characterization of fibers and particulates
Determination of mixtures
Evaluation of pigment and filler dispersion in polymers
Analysis of ceramic, glass, abrasive, refractory, and mineral products

2. Process Evaluation and Failure Analysis

Comparison of good and bad samples
Identification of contamination
Verification of cleanliness of raw materials and in-process products

3. Environmental Analysis

Characterization of settled dusts
Evaluation of filter, e.g., Hi-Vol., PM-10, etc., loads

4. Imaging

Formulation of graphic arts design
Preparation of advertising copy

Principle Of Operation:

Samples of transparent materials are mounted in media of known optical characteristics, and examined in transmitted light. Polarizing filters are placed in the optical path on each side of the sample. In the case of crystalline materials, including many polymers and fibers, the differences in indices of refraction along the crystallographic axes of non-isometric materials resolve the polarized light waves into components which propagate at different rates. These differences in propagation rates create a phase shift. When the wave components are recombined at the polarizing filter on the opposite side of the sample, the phase shift causes wave interference, producing optical effects which can be visually interpreted, or measured.

Variations on the basic technique include employing only a single filter, or rotating the sample and/or the filters. The optical properties of the mounting media may also be systematically varied. Many optical effects are further enhanced by placing accessories in the light path, such as, auxiliary lenses, specially shaped opaque or semi-transparent masks, or wave retardation devices. Volumes of literature on sample preparation and analytical methodology exist, dating well over a century.

Data Output:

PLM results are usually presented as written descriptions of the analyst's observations, estimates, measurements, and interpretations, usually accompanied by photomicrographs. Color views have important technical merit, and often dramatic aesthetic value as well.

Sample Constraints:

Samples must be small and transparent. Large samples are crushed, ground, or cut into very thin slices. Small quantities (as small as a few particles) of sample usually do not present a problem in doing PLM. However, opaque material evaluation by PLM is very limited.

Mounted samples may not be recoverable for other purposes, and some kinds of mounts have short working and shelf life times. Samples may also react with mounting media, thus limiting choice of PLM method.