



# Polarizing/Dispersion Microscope

## ECLIPSE LV100ND POL/DS



# The LV100ND POL/DS comes equipped with accessories for dispersion staining microscopy that aid in the identification of asbestos.

**Qualitative asbestos analysis** The optical properties below can be determined by a polarizing microscope.

## Birefringence

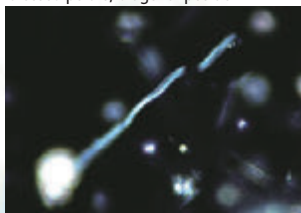
A birefringent crystalline material—such as asbestos—observed under crossed polars alternates four times between light and dark when rotated 360°. This change is due to the alternation between extinction position and diagonal position. In contrast, a single-refractive noncrystalline material, such as rock wool, remains dark when rotated.

**Mixture of rock wool and chrysotile (CFI P Achromat 40x)**

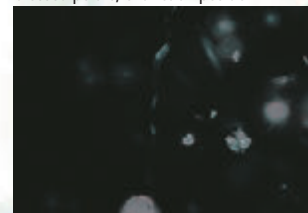
Plain polarized light



Crossed polars, diagonal position

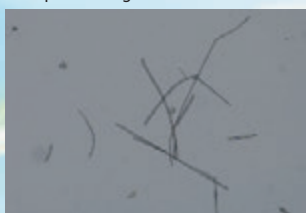


Crossed polars, extinction position



**Rock wool (CFI P Achromat 10x)**

Plain polarized light



Crossed polars

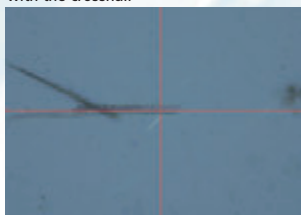


## Extinction angle

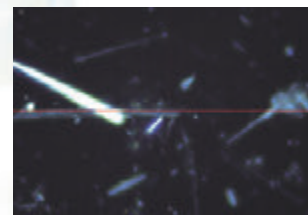
Align the direction of elongation, or cleavage face, of a fiber with either the north-south or east-west crosshairs—vibration direction of the analyzer or polarizer—within the eyepiece. Under crossed polars, rotate the stage until the fiber appears dark (extinction). The rotation angle from the first position to the extinction position is the extinction angle.

**Amosite**

Plain polarized light, cleavage face aligned with the crosshair



Crossed polars, extinction angle measured



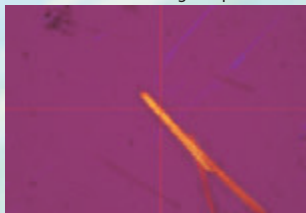
## Sign of elongation

Align a fiber's long axis (direction of elongation) northwest to southeast so that the fiber is at a diagonal position of 45° to the vibration direction of the polarizer. Under crossed polars, insert a 530-nm sensitive tint plate in the optical path and observe the color changes of the fiber.

When the interference color turns yellow or orange, the fiber is at the subtractive diagonal position. This means the direction of the elongation is parallel to the Z' vibration direction (slow axis) and therefore the fiber has a positive sign of elongation. When the interference color turns blue, the fiber is at the additive diagonal position. The direction of elongation is parallel to the X' vibration direction (fast axis), meaning the fiber has a negative sign of elongation.

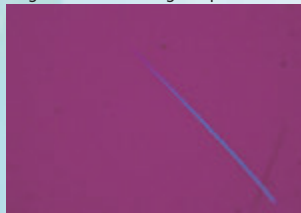
**Amosite**

Positive: Subtractive diagonal position



**Crocidolite**

Negative: Additive diagonal position



**Chrysotile**

Positive: Subtractive diagonal position



(CFI P Achromat 40x)

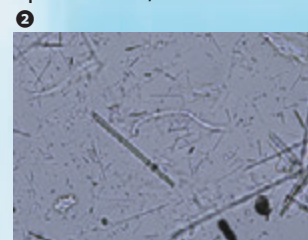
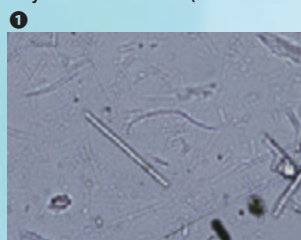
## Refractive index (with plain polarized light)

The refractive index of a specimen can be obtained with the Becke line test (liquid immersion method).

The difference between the refractive indices of the immersion liquid and the specimen is determined by observing the Becke line, which is a bright line visible along a specimen outline. Move down the stage and focus on the upper part of the specimen and the Becke line moves toward the medium—liquid or specimen—with the higher index ❶. Focus on the lower part of a specimen by moving up the stage and the Becke line moves toward a medium with the lower index ❷. The Becke line disappears when the refractive indices of the liquid and the specimen are equal.

By finding the liquid in which the Becke line disappears in reference liquids with given refractive indices, an approximate refractive index of the specimen can be obtained.

**Chrysotile and amosite (refraction index of the liquid nD = 1.605, CFI P Achromat 40x)**



Asbestos is a natural silicate mineral found in rocks. The Asbestos is a natural silicate mineral found in rocks. The properties of asbestos, such as its refractive indices, birefringence, retardation, extinction angle, pleochroism and sign of elongation, can be measured with a polarizing microscope. These optical properties, characteristic to all types of material, help in the identification of asbestos. Nikon developed the LV100ND POL/DS by equipping its high-performance industrial microscope ECLIPSE LV100ND with polarizing units and accessories that enable dispersion staining observations up to 400x.

## Birefringence magnitude and retardation (optical path difference)

The relation between birefringence and retardation is expressed as the formula below. Birefringence ( $n_2 - n_1$ ) can be obtained by measuring retardation (R) and specimen thickness (d).

$$R = d (n_2 - n_1)$$

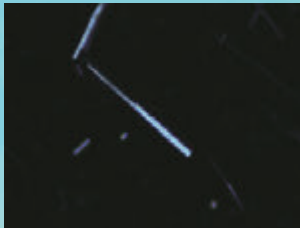
Retardation can be measured with the following method.

- Under crossed polars, rotate the stage until the fiber appears dark to determine the extinction position.
- Rotate the stage 45° from the extinction position to the diagonal position
  - Make sure that the interference color of the fiber turns the lower order color (yellow) when a test plate (530-nm sensitive tint plate) is inserted
  - If it turns the higher order color (blue), rotate the stage a further 90° so that it turns yellow and the fiber is at the subtractive diagonal position.
- Insert a green filter (IF546/12) into the light path. Remove the test plate and insert a Sénarmont compensator in its place. Rotate the analyzer until the fiber is at its darkest and read the rotation angle ( $\theta$ ).
- Find retardation (R) using the formula below.

$$R = \lambda \times \theta / 180 \quad (\lambda: 546 \text{ nm, the wavelength used})$$

Amosite (CFI P Achromat 40x)

1



2



3



## Pleochroism

Specimen colors exhibited by absorption of light with different vibration directions are compared, when either the X' or Z' vibration direction of a fiber is aligned with the vibration direction of the polarizer (horizontal) and when the specimen is rotated 90°. This is observed with a plain polarized light (analyzer removed from the optical path).

Amosite

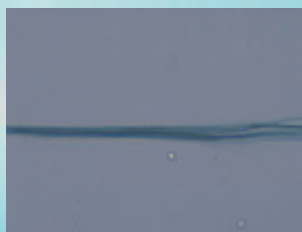


//: Parallel to vibration direction of polarizer

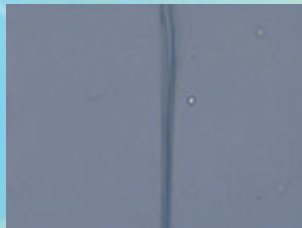


⊥: Orthogonal to vibration direction of polarizer

Crocidolite



//: Parallel to vibration direction of polarizer

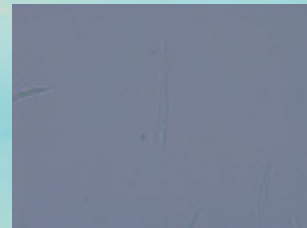


⊥: Orthogonal to vibration direction of polarizer

Chrysotile



//: Parallel to vibration direction of polarizer



⊥: Orthogonal to vibration direction of polarizer

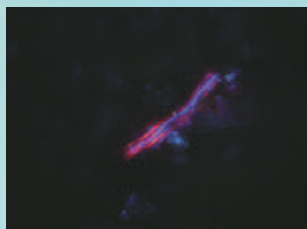
(CFI P Achromat 40x)

## Dispersion colors

Rotate the condenser turret to select a phase ring (Ph1 or Ph2) for phase contrast observation and switch to the dispersion staining objective lens (CFI Plan Fluor 40x DS2) to observe characteristic dispersion colors of each asbestos type corresponding to the refraction index of the immersion liquid.

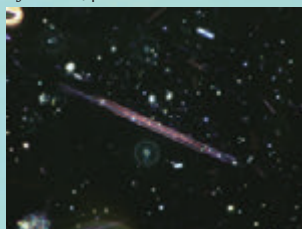
Chrysotile

$n_D = 1.550$ , red-violet to blue



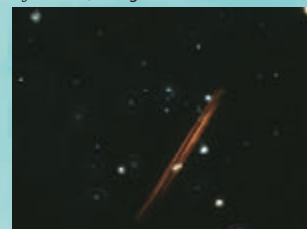
Amosite

$n_D = 1.680$ , pink



Crocidolite

$n_D = 1.680$ , orange to red ochre





## Ideal for image recording of asbestos

The 5.0-megapixel DS-Fi2-L3 digital camera for microscopes is easy to use. The camera control unit has a built-in high-definition 8.4-in. LCD monitor and allows observation and recording without a PC. The large monitor and high frame rate of the camera boost operability. A 100- $\mu$ m diameter concentric circle similar to an eyepiece graticule can be displayed for measurement. Two modes (red/blue) that allow imaging of asbestos with optimum color balance are available.

Combination example: DS-Fi2-L3 configured with ECLIPSE LV100ND POL/DS

### Specifications

Main body	Optical system	CFI60 infinity
	Illumination	New illuminator (brighter than 100 W)
		12 V-50 W halogen lamp (new LV-HL50W model); 12 V-50 W DC transformer built-in; Precentered lamphouse with rear mirror; Diascopic/episcopic illumination changeover switch; Fly-eye lens built-in; ND8, NCB11 filters detachable
Focusing	Coaxial coarse/fine focus knob; Focus stroke: 30 mm; Coarse: 14 mm per rotation; Fine: 0.1 mm per rotation; Minimum reading: in 1 $\mu$ m increments (left: coarse/fine, right: fine focus knob)	
Eyepiece	10x; F.O.V. 22; CM type with crosshair and micrometer scale, Eyepiece graticule for asbestos	
Eyepiece tube	P-TT3 Trinocular Tube for polarizing microscopy; With crosshair adjustment ring	
Polarizing intermediate tube	Analyzer detachable; Orthoscopic/Conoscopic observations switchable; With plate/compensator slot; Focusing and centering Bertrand lens	
Analyzer	360 ° rotary dial; Minimum reading angle 0.1 °	
Nosepiece	Reversed centering quintuple nosepiece (detachable); With DIN compensator slot	
Stage	High-precision circular graduated stage for polarizing microscope; Rotatable 360 ° horizontally; Can be fixed at a specific position; Graduated in 1 ° increments (0.1 ° readings with sub scale); 45 ° click stops	
	Attachable mechanical stage; Vernier 0.1 mm	
Condenser	LV-CUD Universal Condenser Dry (NA 0.9), D-C PH1, D-C PH2 and LV-C 2-4x Lens are required P Swing-out Condenser (Option)	
Polarizer	C-SP simple polarizer; one-touch swing-out type	
Objectives	Polarizing: CFI P Achromat 4x, 10x, 20x, 40x Dispersion: CFI Achromat 10xD, CFI Plan Fluor 40x DS2	
Compensators	P-CL 1/4 $\lambda$ & tint plate, quartz-wedge compensator or Sénarmont compensator can be inserted into polarizing intermediate tube slot	
Measuring filter	IF546/12 retardation filter ( $\varnothing$ 45 mm)	
Power consumption	1.2 A/75 W	

Specifications and equipment are subject to change without any notice or obligation on the part of the manufacturer. March 2013 ©2000-13 NIKON CORPORATION



#### WARNING

TO ENSURE CORRECT USAGE, READ THE CORRESPONDING MANUALS CAREFULLY BEFORE USING YOUR EQUIPMENT.

Monitor images are simulated.

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