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(Hons) paper-iii lecture no-68

## Topic: Nicol Prism

A special prism for producing polarized light, made from two pieces of Iceland spar (calcite) cemented together with Canada balsam. Light entering the prism is split into two polarized rays; of these, the ordinary ray is totally reflected at the balsam layer while the extraordinary ray is able to pass through the prism. In a petrological microscope two Nicol prisms are incorporated.

Its working is based on a phenomenon of **double refraction**. In double refraction an incident ray splits into two component rays called as **ordinary ray** (O- ray) and **extra ordinary ray** (e-ray).

O-ray obeys ordinary laws of physics and is plane polarised E-ray does not obey ordinary laws of physics. It is also polarised.

The two rays are plane polarised.in mutual perpendicular planes.

### • Optic Axis

It is a direction inside the crystal such that the single ray of light does not split into O-ray and E-ray as their velocities are equal.

Double refraction or birefringence is not observed along optic axis.

### • Principal plane and Principal section

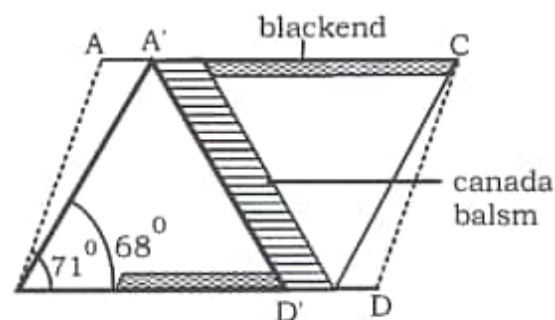
A plane containing the optic axis and perpendicular to the opposite faces of the crystal called **principal plane**.

Section of a crystal along principal plane is called **principal section** of the crystal.

### • Construction of Nicol Prism

A calcite crystal of length 3 times its breadth is cut along the proper direction. Its principal section is a parallelogram of  $71^\circ$  and  $109^\circ$  angles.

The two pieces are ground so that the angles of principal section are changed to  $68^\circ$  and  $112^\circ$ . As shown in the figure.

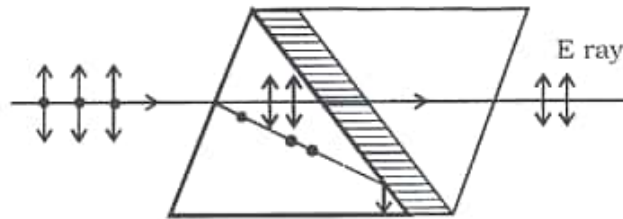


The two pieces are joined together along diagonal AD by sticky liquid known as Canada balsam. The side faces are blackened.

**Working** : Nicol as polariser.

A ray of light is split into O-ray and E-ray which are both polarised.

O-ray has vibrations perpendicular to principal section. RI of calcite for O-ray is 1.658 and RI of Canada balsm is 1.55. Thus for O-ray the calcite crystal is denser medium. It is totally reflected by Canada balsam and absorbed by blackened surfaces.



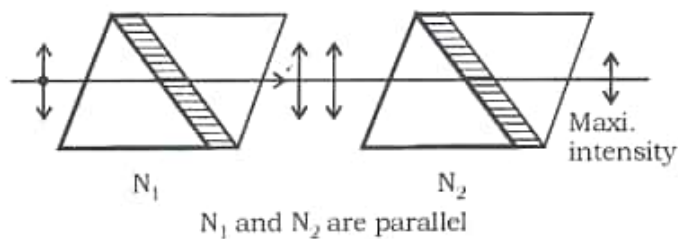
E ray has vibration in the plane of principal section

RI of the crystal for E-ray is 1.486. Calcite behaves as rarer medium. So it is transmitted by Canada balsam and finally emerges out of the crystal as polarised beam of light.

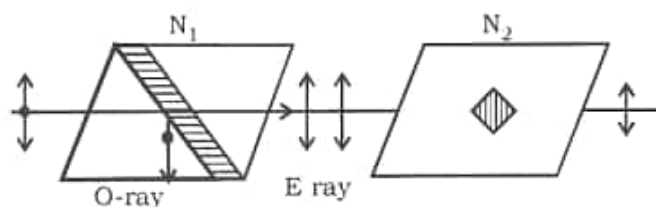
● **Nicol as Analyser**

Two nicols  $N_1$  and  $N_2$  are arranged in the line of incident ray.  $N_1$  is polariser and gives out a plane polarised light.

(i) Two nicols are parallel, i.e. their diagonals of principal sections are parallel.



(ii)  $N_1$  and  $N_2$  are crossed. The principal section of  $N_1$  and  $N_2$  are perpendicular. E-ray becomes O-ray as its vibration are perpendicular to principal plane of  $N_2$ . So the ray is totally reflected and absorbed by side faces.



Thus intensity is zero for emerging light. Rotation of  $N_2$  can detect plane polarised and unpolarised light. Hence  $N_2$  is called analyser.