

Plane Polarized Light: A Brief Introduction and Application in Stereochemistry

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Abstract: Plane polarized light is an important discovery in the history of science. It has many important uses including in the field of stereochemistry. It was Biot, a French physicist who first observed that certain molecules can rotate the plane of plane polarized light, a phenomenon which was later called as optical rotation. In fact, this observation makes the beginning of the stereochemistry. In order to have a clear idea about optical activity, its relation with molecular structure and symmetry an undergraduate must have a brief idea about - what is plane polarized light? This mini - review aims to address that question.

Keywords: Plane polarized light, plane of vibration, plane of polarization, stereoisomer

1. Introduction

Stereochemistry¹ is a branch of chemistry that deals with three - dimensional arrangement of atoms and groups in space. When two different molecules will have same molecular formula, they should be called as isomers. Two structures may represent two different molecules with huge difference in physiochemical and biological properties, even if they have same molecular formula, same type of bond sequencing, same type of functional groups etc. These structures will only have different orientation or position of atoms or groups in space and that will make two structures to represent two different molecules and these types of molecules are called stereoisomers. One of the important properties of stereoisomers is their behavior towards light and in particular, towards plane polarized light. Some of the stereoisomers can rotate the plane of plane polarized light in a clockwise or anti - clockwise direction and depending upon that stereoisomers have been named as dextrorotatory or levorotatory. This observation made the initial foundation of stereochemistry in the long days back in 1815.² Before that, the plane polarized light was discovered by Malus in 1809.³ This property is useful and employed to characterize and distinguish among stereoisomers. This brief review is aiming to provide a brief understanding of - what is plane polarized light or what is the meaning of its plane?

Light as Electromagnetic Wave

In the electromagnetic theory, light⁴ is considered as a transverse electromagnetic wave. Wave is of two types - longitudinal and transverse. The phenomena like interference; diffraction etc. can be explained in terms of both longitudinal and transverse concept. But it is the phenomenon of polarization that specifically needs light must be transverse in nature. Light is consisting of vibrating electric field and magnetic field vectors at right angle to each other and also to the direction of its propagation. All electromagnetic wave is consisting of two waves, i. e., one is vibrating electric field and another is vibrating magnetic field which are perpendicular to each other. Electromagnetic waves can carry energy and momentum and transfer them from the source to the matter during the interaction. The energy streaming through the space in the form of

electromagnetic wave is shared equally between constituent electric and magnetic fields. The electric vector is called the light vector because it is responsible for the sensation of vision.

In the ordinary light, there are thousands of waves, the light vectors of the component waves will be in all possible directions on a plane say, ABCD (Fig.1) at right angles to the direction of propagation say, XY.

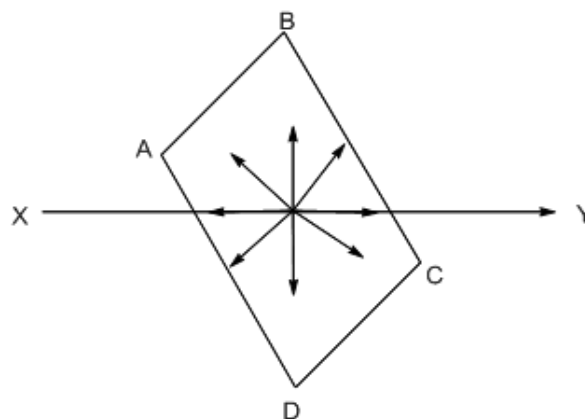


Figure 1

Such a light beam with electric vectors arranged symmetrically about the direction of propagation is known as natural or unpolarized light. The electric vibration of unpolarized light may be resolved into component - one along the plane of the paper and another is perpendicular to the plane of paper.

If by some means, one of these component vibrations is cut off, then we shall have vibrations of all the component waves confined in one definite direction (or on a particular plane). Such a light beam is said to be plane polarized light.

Representation

The representation of unpolarized and plane polarized light is shown below - unpolarized light is consisting of vibration in all direction in a plane perpendicular to the direction of propagation, is usually represented by dots and arrows (Fig.2a)

Figure 2 (a)

In plane polarized light, when the vibrations are in the plane parallel to the plane of paper, it is represented by a straight arrow shown in the (Fig.2b) and when the vibration lies in a direction perpendicular to the plane of the paper, it is represented by a dot (.) (Fig.2c)

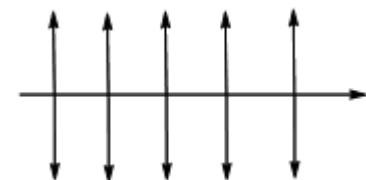


Figure 2 (b)



Figure 2 (c)

Plane of Vibration

The plane in which the vibrations of polarized light are confined is known as the plane of vibration -

The plane ABCD (Fig.3) that contains the directions of vibration and also the direction of propagation shown in the Figure. This plane contains the electric vector and the propagation vector.

Plane of Polarization

The Plane perpendicular to the plane of vibration and hence containing no vibration is called the plane of polarization. This plane abcd (Fig.3) passes through the direction of propagation and is at right angle to the plane of vibration.

Figure 3

2. Conclusion

Basically, feelings of writing this article came from dealings of the undergraduate in the stereochemistry classroom. The polarization of light is topic much discussed in Physics textbook. Herein, a brief discussion has been made for the students who are aspiring to take chemistry as the major in their graduation. Hope, this letter will be helpful to the young undergraduates in the initial days of stereochemistry. We shall continue our journey of understanding basics of stereochemistry in upcoming days.

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