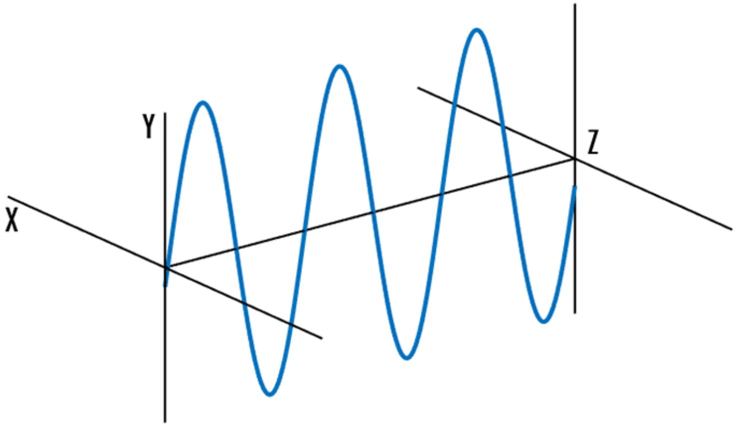
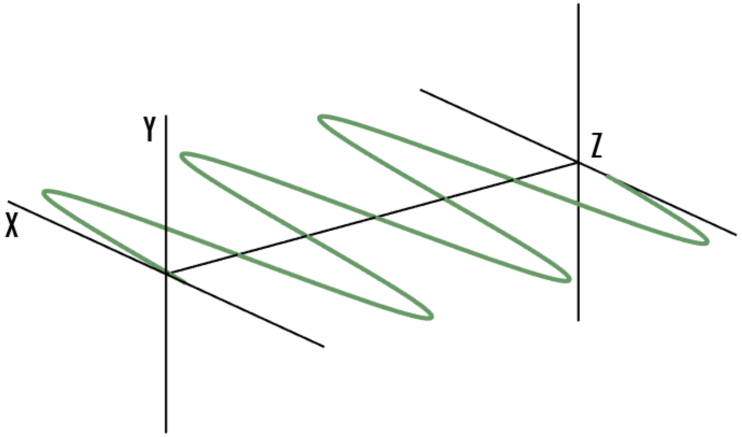
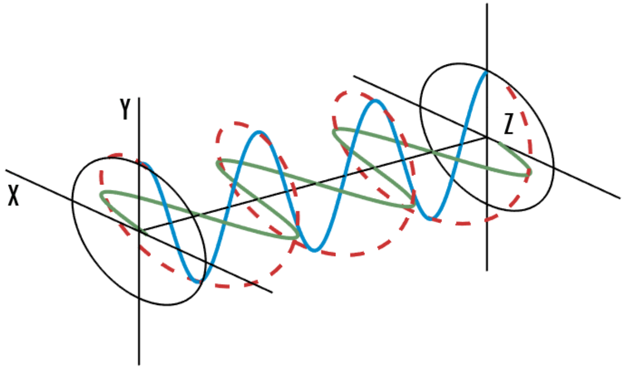
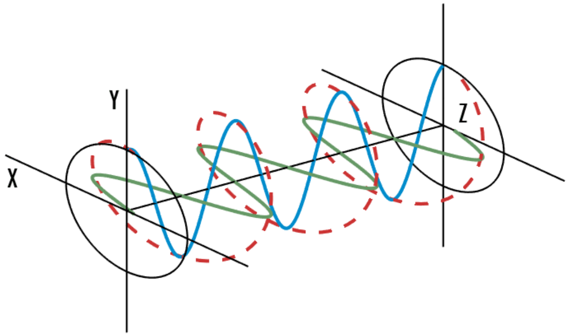




Polarization





https://www.edmundoptics.com/knowledge-center/application-notes/optics/introduction-to-polarization/

Expected for you to answer:

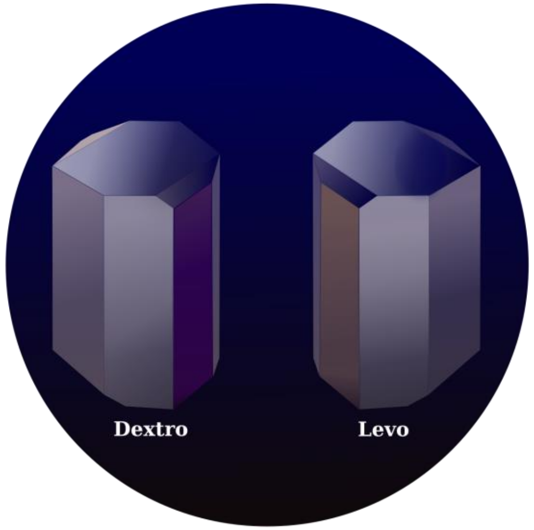
1) What is the relation between the direction of the polarized light and the director of the liquid crystal (LC)?

2) How the nano world is related to this?

3) Could a nocomposite of Carbon Nanotubes/LC have better properties than those of the plain LC?

The rotation of the orientation of linearly polarized light was first observed in 1811 in quartz by French physicist François Jean Dominique Arago.[1] In 1820, the English astronomer Sir John F.W. by equal amounts but in oppositHerschel discovered that different individual quartz crystals, whose crystalline structures are mirror images of each other (see illustration), rotate linear polarization te directions.[2] Jean Baptiste Biot also observed the rotation of the axis of polarization in certain liquids[3] and vapors of organic substances such as turpentine.[4] Simple polarimeters have been used since this time to measure the concentrations of simple sugars, such as glucose, in solution. In fact one name for D-glucose (the biological isomer), is *dextrose*, referring to the fact that it causes linearly polarized light to rotate to the right or dexter side. In a similar manner, levulose, more commonly known as fructose, causes the plane of polarization to rotate to the left. Fructose is even more strongly levorotatory than glucose is dextrorotatory. Invert sugar syrup, commercially formed by the hydrolysis of sucrose syrup to a mixture of the component simple sugars, fructose, and glucose, gets its name from the fact that the conversion causes the direction of rotation to "invert" from right to left.

In 1849, Louis Pasteur resolved a problem concerning the nature of tartaric acid.[5] A solution of this compound derived from living things (to be specific, wine lees) rotates the plane of polarization of light passing through it, but tartaric acid derived by chemical synthesis has no such effect, even though its reactions are identical and its elemental composition is the same. Pasteur noticed that the crystals come in two asymmetric forms that are mirror images of one another. Sorting the crystals by hand gave two forms of the compound: Solutions of one form rotate polarized light clockwise, while the other form rotate light counterclockwise. An equal mix of the two has no polarizing effect on light. Pasteur deduced that the molecule in question is asymmetric and could exist in two different forms that resemble one another as would left- and right-hand gloves, and that the organic form of the compound consists of purely the one type.



The two asymmetric crystal forms, dextrorotatory and levorotatory, of tartaric acid.

In 1874, Jacobus Henricus van 't Hoff[6] and Joseph Achille Le Bel[7] independently proposed that this phenomenon of optical activity in carbon compounds could be explained by assuming that the 4 saturated chemical bonds between carbon atoms and their neighbors are directed towards the corners of a regular tetrahedron. If the 4 neighbors are all different, then there are two possible orderings of the neighbors around the tetrahedron, which will be mirror images of each other. This led to a better understanding of the three-dimensional nature of molecules.

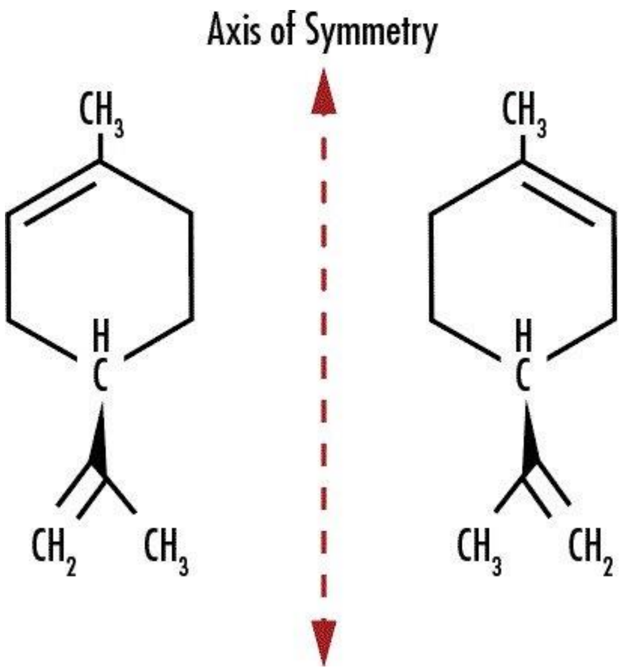


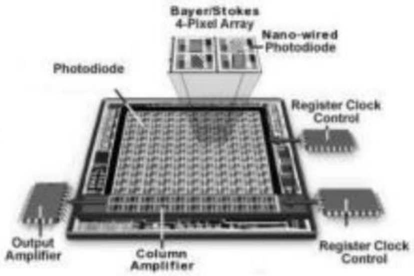
Figure 13: (+)-Limonene, or D-Limonene (left), is associated with the smell of oranges as oranges have a higher concentration of this stereoisomer than the other. (+)-Limonene rotates the orientation of incident light. (-)-Limonene, or L-Limonene (right), is associated with lemons because it is highly concentrated in lemons, and it rotates incident light in the opposite direction as (+)-Limonene.

Got o Blackboard
1) Session 7
2) Papers
3) Read…

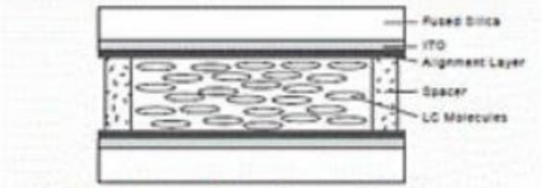
"How do LCDs (liquid crystal displays) work"

Application

Liquid Crystal Variable Retarders



A "classical" polarimeter, in the <u>easiest</u> configuration, comprises a rotating quarter wave plate and a fixed linear polarizer.
For the fully characterization of the linear polarization the knowledge of the I, Q and U parameters is needed.
For that reason at least 3 measurements in a 3 different positions (or retardances) of the quarter wave plate are required.



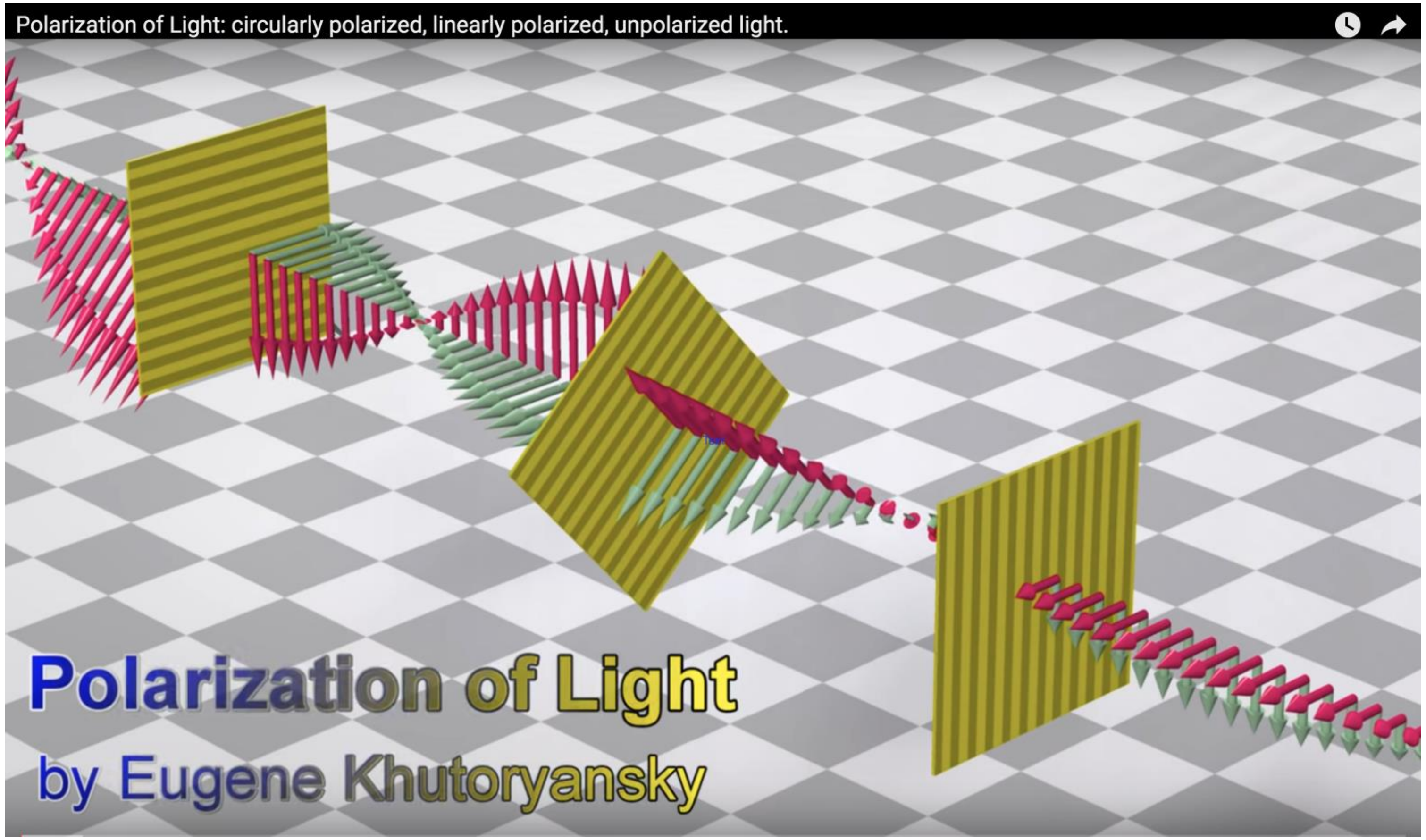
(a) Maximum Retardance (V = 0)

(b) Minimum Retardance (V >> 0)

The Liquid Crystal -based retarder (LCVR) acts as a variable retarder.

The variation in retardance is introduced by the variation of birefringence that change with the alignment of the liquid crystals sensible to an applied electric field. By the application of calibrated external voltages, different retardances values are immediately set without using moving mechanical parts.
This is one of the most relevant advantages on the use of this technology, especially for their use in space .

Watch video

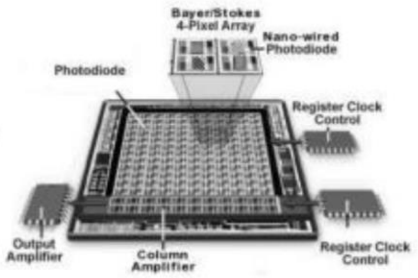


Click there

https://www.youtube.com/watch?v=8YkfEft4p-w

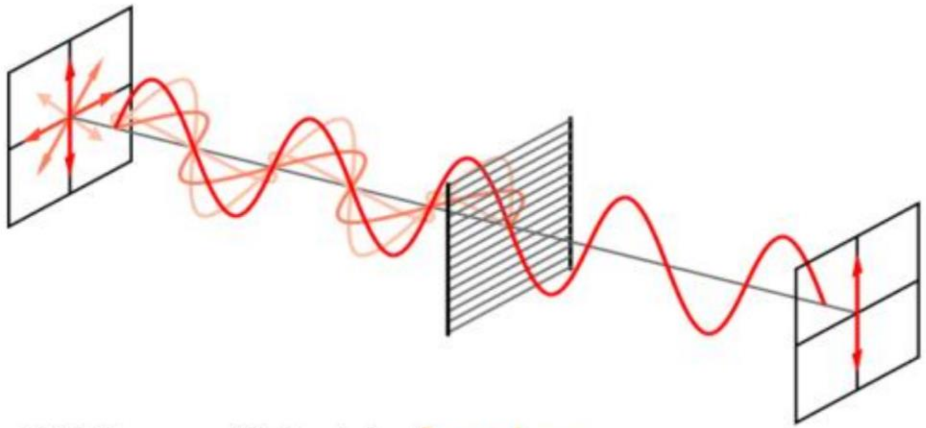
Polarization and the nano world

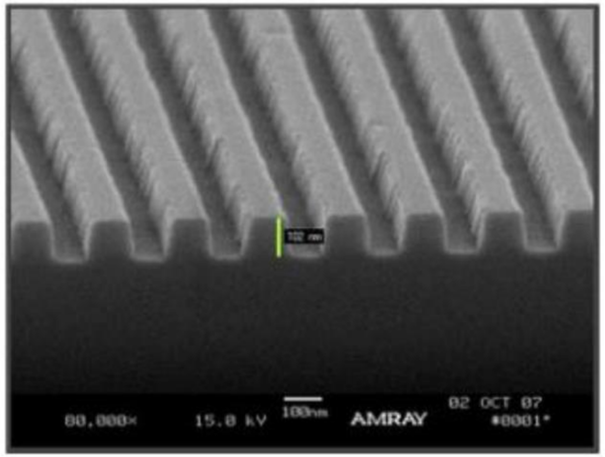
Wire Grid Polarisers



A WGP consists of a regular array of fine parallel metallic wires (e.g. Al), placed in a plane perpendicular to the incident beam.

The component of the electromagnetic waves with electric field aligned parallel to the wires is **reflected** by the WGP whereas the other component (electric field perpendicular to the wires) is **transmitted**.

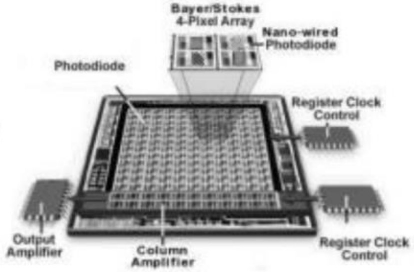




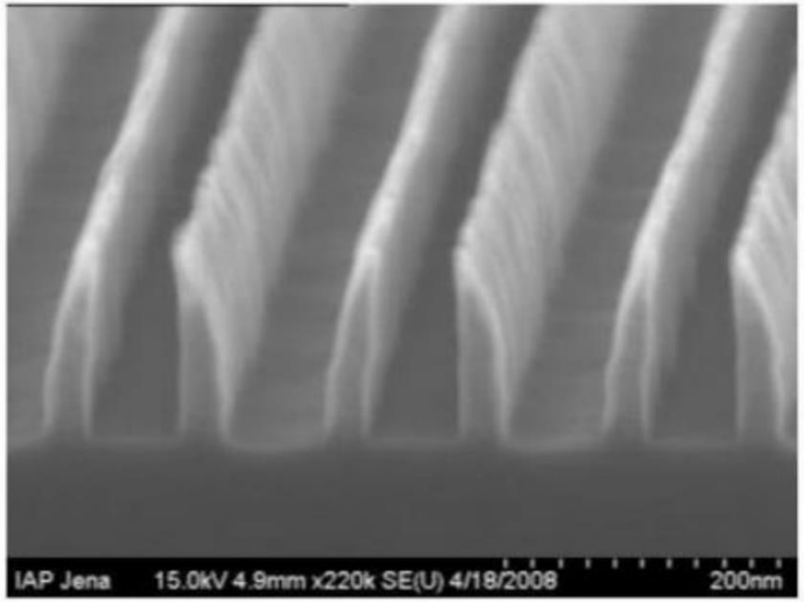
Note: WGPs are efficient for $\lambda \geq 3\ L_{pitch}$.

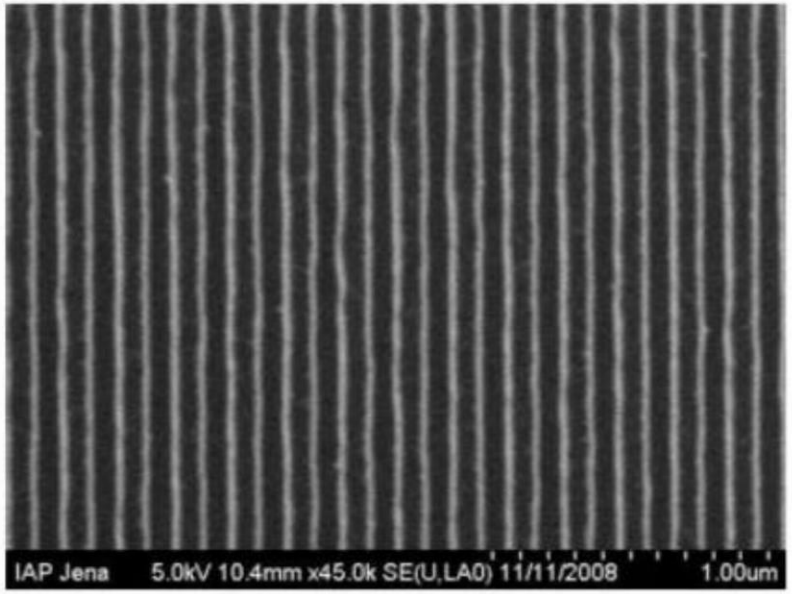
Wire-grid based polarizers have been extensively used so far for ground-based application in the infrared and in the visible region. Now their usage should be extended **to space**...

Wire Grid Polarisers



Recently, the remarkable improvement in nano pattern generation made by lithography techniques, (electrons beam or ions beam lift-off) brought the wire grid polarizers to have the potential to generate a broadband polarizer even in the **UV range**, where grids pitches are challenging.





Weber T. et al, "*Wire-Grid Polarizer for the UV spectral region*", Proc. SPIE 7205 (2009).

For those who want to go deeper

For those who want to go deeper

Polarization

https://www.physicsclassroom.com/class/light/Lesson-1/Polarization

EM Waves (Matt Anderson**)**

https://www.youtube.com/watch?v=bwreHReBH2A

Electromagnetic waves. EM spectrum, energy, momentum. Electric field and magnetic field. Doppler shift. Polarization.

Questions to be answered by the end of Session 7

1) How to synthetize Zero Order Nanoparticles (ZON) using micelles?
2) What are the phenomena defining the size of the nanoparticles?
3) What are plasmons?