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Light and color

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abstract

Nanoscale Smart Materials in smart layers have been a challenge in the industrial, electronics, medical, and construction sector. Smart materials are materials that are able to understand their environment and react surroundings. Chromic materials, photochromic materials, electrochromic, thermos-chromic material are the components able to change the color of light through electromagnetic wavelengths since the light is a quality that affects the visual sense and thus the objects become visible. But the definition of light today is that the light has waves in which the affected eye can see colorful environment which is called the theory of light waves and the concept in smart materials is formed through response sense and affects the color and clarity in the color, shape and size change of material. Gold nanoparticles in various 3-side forms have different properties with 1 Angstrom sizes. The color of 1 nm materials is yellow and between 3 and 30 nm is green. Color change can now be applied in various fields. V frequency of energy can change color and in the ultraviolet, microwave, infrared has a vibration between micron dimensions. Physical conditions of the wave intensity and wave power represent the reflected color. In 1900, Planck's constant equation is and which is used for the light intensity. Chameleon color change is one of the patterns that can change color through electromagnetic waves and convert the light into different colors. For this purpose, pigments' design and volume are very necessary and practical to change color and to create smart environments able to change the color.

Keywords: Color. Dielectric properties. Periodic structure. Crystal

INTRODUCTION

Today, the global wavelengths are a range of concepts, methods, information and formulas of wavelengths interacting with the environment which transmit the information from the environment by the help of color. In general, it can be said that colorimetric is based on the light analysis of the objects and the light tries to release message through distributed colors. Materials such as pigments and octopus chameleons change through receiving the frequency from the nervous system and $ph\,(zr_{1-x}Ti_x)O_3$ materials all have dielectric and $1D, 2D, 3D$, crystals for color publication that each of the crystals has a (PBG) bandgap. Each band has a/z since each wavelength effects $E\,‹Hekxt^i\,(\;.\;-\omega\,)$ of the field where the wave vector $|k| = \omega / c = \frac{2\pi}{\lambda}$ equals to the vector silicon (1/11) of $pzt(1200)knbo3(700)(6/9)$ glass which the materials with dielectric can contribute to the propagation of a wave. Photonic Bandgap (PBG) actually means that the properties of holes or dielectric are designed as a structure periodically for repeats an intermittent operation (fixed wavelength colors) used to analyze the structure of the periodic Fluker-Bloch.

$(k.x-\omega t)e_i$ The release of the same surface wave has periodic power $H^2 \rightarrow (X)$ to analysis of the structure in $H(\mathrm{x,t}) = \mathrm{e}^\wedge \mathrm{i}(\mathrm{k.x}.\varpi\,\mathrm{t})$ to study perovskite crystal structures of $ABO3$ that are crystallized.

A is the cation and B is the anion in this formula. For alternating crystalline structure in the first stage, its assembly position studied the position of B $(1/2,1.2,1.2)$ with the understanding of the position of $A(0.0.0)$. Electric torque has been considered to study the material since $phtio3$ has not electric torque. We can make pigments through the method that has been wavelength frequency with the performance to change the color. If the wavelength is not fit a one-dimensional crystalline structure and the width $\lambda - za$ of that equation is clear, the specific wave is not twisted or re-twisted. According to Figure (1-1), the waves with wavelengths outside the stop band do not enter into the one-dimensional crystal.

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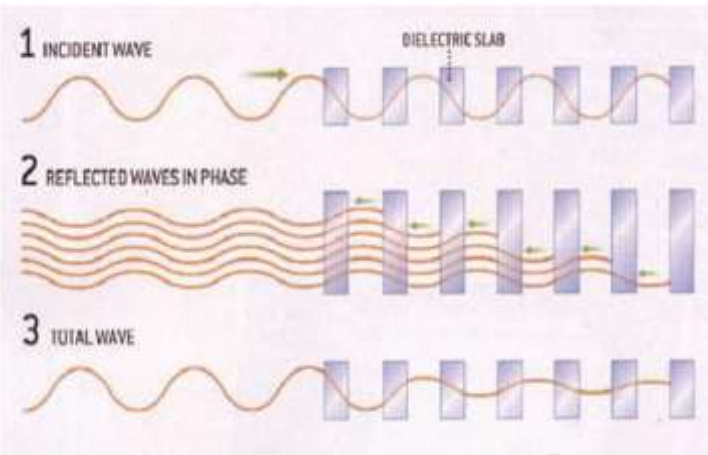

Figure (1-1): alternate structures to reflect the wavelength

The reflected waves are not in a same phase and undermine each other. Thus the passing wave is very weak. The effects of this band gap can be observed in nature on butterfly wings. Figure (1-2) determine the structure of the material.

Figure (1-2): the periodic structure of a crystalline substance in nature to reflect light and see the color of the wings of a butterfly.

The density with DFT computing is considered to study the structure of the material. As noted above, the density type and the functionality of the wave should be noted to reflect a wavelength of a substance. $fp-LAPW$ method has been used to amplify linear waves. There are two operation ways for this method which are: $fp-LAPW$ - $LAPW$

The wave function in the $\varphi KJ(R)=\frac{\varepsilon}{G}CJ(K+G)\Phi LAPW$ $K+G(R)$ method using wave functions based on a combination of radial functions $U_i(r)\,\mathrm{Y}_{im}(r)$ spherical harmonica is

$$\phi_{K+G}^{LAPW}(r)=\left(\begin{matrix}\frac{LMAX}{\Sigma}\\ \mathrm{i,m}\\ \left(\frac{1}{\sqrt{}}e(\mathrm{k+g})\right)r\end{matrix}\right)(\mathrm{A_{i,m}(K+G)\,ui(r,\Sigma i)}+Bi,m_{r\in II}(k+g)ui(r,\Sigma\mathrm{i})\,\mathrm{Y_{i,m}}(\phi,\theta)r\in I$$

$$\left(-\frac{h_2}{2m}\frac{\sigma\wedge 2}{\sigma r\wedge 2}+\frac{h\wedge 2}{2m}\frac{l(l+1)}{r\wedge 2}\right)+v(r)-Ei)ru_i(r,\mathrm{E_i})=0$$

Where G is reverse grid vector and K is Brillouin zone vector and both Bim and Aim are obtained in the sphere of Maffin-tin wave functions. As we know, potential has lots of changes in density of wave function around the core and the potential becomes far from the core and it can be considered in terms of the wave function and the type of wave function in the following figure can be of the group I and II which are flat in which I is a plane wave in the near spherical inner core of Maffin-tin. It is also considered as II and spherical harmonica. As a result, the equations can be named wavelength and can have wavelength behavior. For this reason, we can see the world in color or with different colors.

Crystal have been divided into various parts, including:

- one-dimensional crystal
- two-dimensional crystals
- three-dimensional crystals

The two-dimensional crystals:

The structures are the arrays of dielectric cylinders in the air and pitted page.

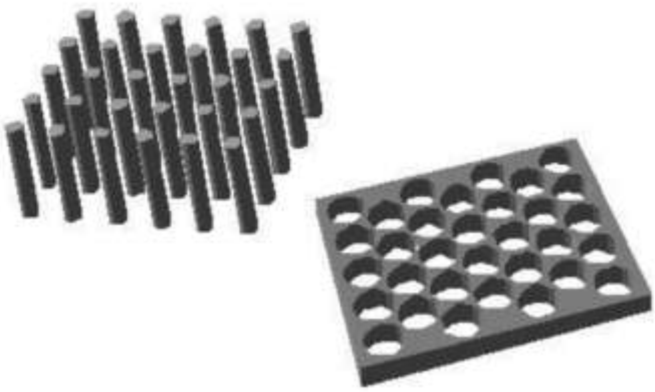

Figure 1-3: array of two-dimensional crystals

If the determined wavelength by PBG structure is two-dimensional, band gap structure will be two-dimensional and each unit cell of the structure reflects the waves and therefore undermines reflected incoming waves severely.

3D Photonic crystals:

These crystals have FCC Yablonovit structure, a wooden handle structure، an inverse glass structure, a square spiral structure and a wooden structure.

FCC:
Look at FCC structure. The structure in horizontal and vertical level was periodic and the bars include dielectric, air holes, the radius of hole is $0.293a$ and the height of the hole is $0.93a$ and the structure is $0.21PBG$ and dielectric constant is $\varepsilon = 12$.

Studying $phzro3$ Compound:

This compound has lead and the crystal lattice constant has a square structure and external network constant is $a = 4/088\lambda$ and spatial group is $pm3m$ and has 32 symmetry. An object must have large optical energy gap to reflect light or color. the energy gap of $phzro3$ is $xEg = 3/166e.v$. Totally, it can be said that the indirect band gap background the elegant bar is determined at the max point m and the min point x of conduction band. As you know, today $Tio2$ oxide have been used in sunscreens. The substance is between one and one hundred nanometers using nanotechnology. A waterproof is therefore used which appears colorless on the skin. Previous sunscreen reflected light of the sun by absorption wavelength and thus appear sunscreen on the skin. In general, if we want to get the science of being colorless or invisible, particles with long wavelength must reflect small wave based on their particle size. As a result, this performance receives lots of interest in invisibility. Figure (1-4) determines density of states and band structure of $phzro3$.

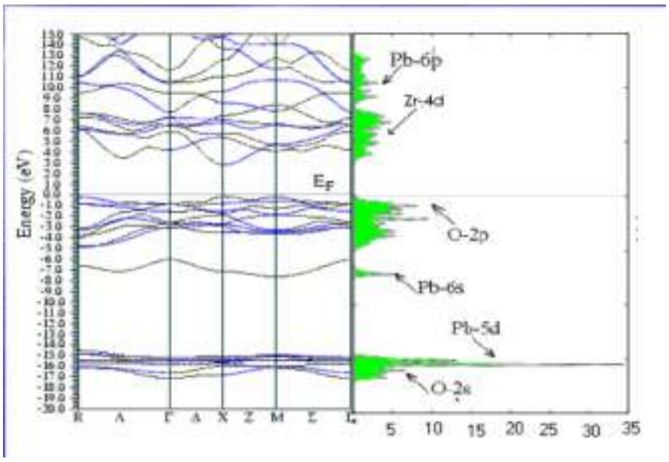

Figure (1-4) shows the effect of the density of matter on the reflect from a surface

This combination $ph(zro6bTio33)o3$ has a tetragonal network and $p4mm$ space group and the network $a = 4/046/6A = 30 = 4/136A$ in this equation that there is a Ti atom in $<001>$ for each Zr which is replaced by Zr atom and thus it can be said that this matter has had eight crystal symmetry and indirect band gap is $Eg = 1/9Ae.v$ and therefore the size of the orbitals is reduced.

In fact, we can say that color is an electromagnetic length which is observable by human eye. Human eye can see the wavelengths between 400 to 800 mili-micron. In fact, we can say that the nature of colors is not physical, but the wavelength can be seen as colorful in two cases: A- the physical state of the environment to reflect, B- the absorption of the eye from the environment, resulting in a color vision from the environment and it can be said that the color of the incoming wave length depends on the frequency. Each color has a specific wavelength and frequency which is shown in Figure (1-5).

Figure (1-5) light frequencies and its reflection from the frequency

To see a white band visible at all times, in fact, the energy of EM electromagnetic wave is the same in visible band and also if band filed itself does not reflect any wavelength (λ), we see the whole or surface as black. In 1676, Newton proved that the rays of white light can be broken by a prism optics to show a colored multi-band layer. Figure (1-6) shows wavelength of the prism.

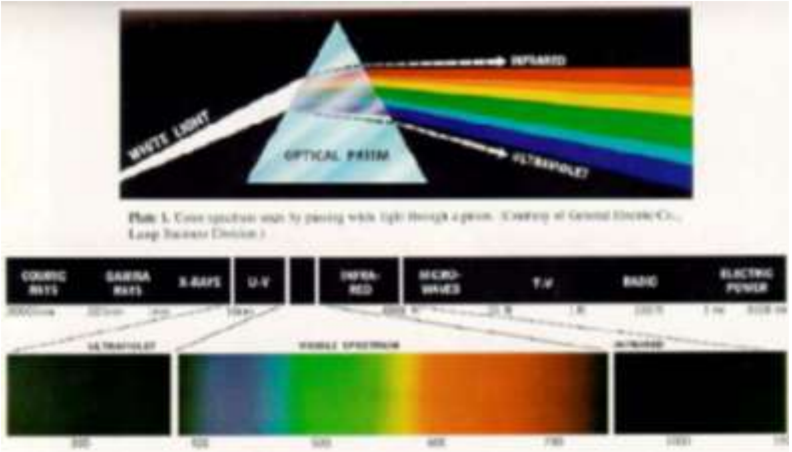

Figure (1-6): the spectrum analysis of light by the optical Charter

Knowledge of color theory for the whole wavelength makes 4 awesome models for the scientific justification of color and light which are:

- Front (Hue)
- Saturation
- Brightness(HAB)
- *RGP*

HUE model:

This model is based on human perception of color. All colors in *HSB* are based on 3 basic features described. The color space are described in *Hue*, for example, orange or green are determined by the returned wavelength of light by the object by passing it. As measured location on the standard color circles are presented with an angle between 0 to 360. Figure (1-7) shows standard circular of colors appears for the eye.

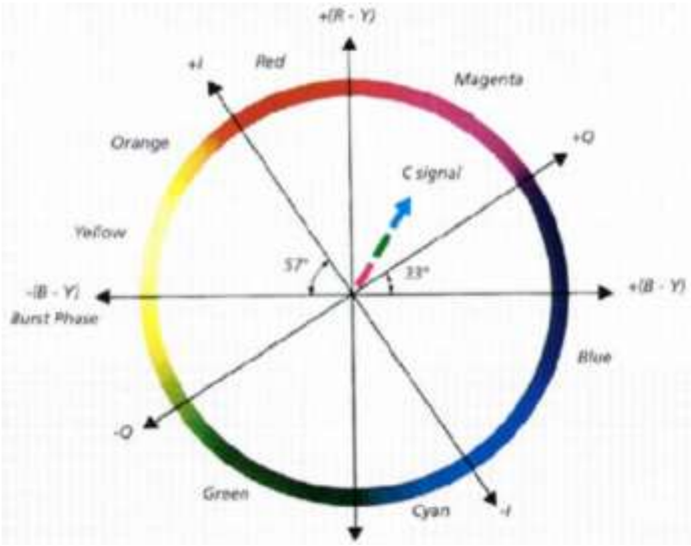

Figure (1-7) shows Standard circle of colors and the angle of reflection

In general, it can be said that we see all the objects colorful due to the reflected colors to our eyes and the objects reflected with short wavelength to our eyes are invisible for us.

Conclusion:

Today, the use of nanotechnology in the field of colors would improve the science of light. It general, by some materials with identified density as well as studying the properties of dielectric materials, surface materials can be created that the surface can be colored by the reflection of them. Colored vision to the objects and environments is only due to the reflection of the light from the environment to *the human eye.*

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