Role of Luminescence in Modern Era in Relation to Human Being Development

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Abstract

In this paper an attempt has been made by author about the role of luminescence in modern era in relation to human being development. Luminescence is a general term to describe the process in which a material absorbs energy from an external source and re-emits that energy in the form of visible light. Luminescence is a subject that continues to play a major technological role of human mankind. Luminescence is the phenomena in which all or part of absorbed energy is re-emitted in the form of electromagnetic radiation in the visible in the near visible region of the spectrum. Luminescence varies depending on the type of energy that excites the electrons and also the process used to induce luminescence. There are so many luminescence i.e. photoluminescence, Cathadoluminescence ,electroluminescence, chemiluminescence,bioluminescence,radioluminescence,thermoluminescence,mechanoluminescence,Sonoluminescence,Crystalloluminescence,lyoluminescence,candoluminescence,super luminescence, negative luminescence, cross luminescence, anti-stoke luminescence. Luminescence plays pivotal role in the life of human being.

KEYWORDS: Luminescence, absorbed energy, visible light, electromagnetic radiation.

INTRODUCTION:-

The progress in the development of luminescence materials and techniques has been dramatic over the last three decades, current interest have moved from traditional lamps and displays to medical and solid state lighting . Luminescence, in Latin the meaning of lumen is light; is the re-emission of light from an object upon being excited by another light or energy source. When a substance absorbs energy in same form or other, a fraction of the absorbed energy may be re-emitted in the form of electromagnetic radiation in the visible or near visible region of the spectrum. This phenomenon is called luminescence. Luminous simply means giving off light; most things in our world produce light because they have energy that originally came from the sun, which is the biggest, most luminous thing we can see. Luminescence is the generation of light without heat . In other words, light emission that cannot be attributed merely to the temperature of the emitting body is known as the luminescence. There are two principal processes which cause the emission of light: Incandescence and Luminescence, the phenomenon of cold emission of light is known as luminescence. Scientifically luminescence is a light emission which represents an excess over the thermal radiation and lasts for a time exceeding the period of electromagnetic oscillation. Luminescence is ‘cold light’ that can be emitted at normal and lower temperatures. In luminescence some energy source kicks an electron of an atom out of its lowest energy ‘ground’ state into a higher energy ‘excited’ state, then the

electron returns the energy in the form of light so it can fall back its 'ground' state. With a few exceptions, the excitation energy is always greater than the energy (wavelength colour) of the emitted light. Luminescence may occur in a solid, liquid or gas. A solid object that will become luminescent is called a phosphor. Luminescence process involves at least three steps: (i) energy absorption causing excitation (ii) Storage of absorbed energy, and(iii) emission of photons. Depending on the storage time, i.e. the time delay between the excitation and emission luminescence can be classified into two categories. If the storage time is shorter than 10^{-8}s, the process is termed as fluorescence; otherwise it is termed as phosphorescence. In other words, the fast emission is called fluorescence and slow emission is called phosphorescence. When talk about 'luminous' watches and point what we really mean is phosphorescence, which is very similar to fluorescence, the process by which energy saving lamps make light. Fluorescent materials produce light instantly when the atoms inside absorb energy and become excited, when the atoms return to the normal in as little as a hundred thousandth of a second, they give out the energy that excited them as tiny particles of light called photons, shine ultraviolet(UV) light on a TV or camera and we might find someone's address shining back, written in invisible ink. The ink is made of fluorescent chemicals that absorb energy from the UV light become excited and then give out the energy as photons of visible light. Switch off the UV light and the ink disappears again.

When Wiedmann in 1888 recognized luminescence as the anti-thesis to incandescence, he also classified luminescence into six kinds according to the method of excitation**[3].** He recognized photoluminescence, thermo-luminescence, electroluminescence, crystallo-luminescence, tribo-luminescence and chemi-luminescence. The designations are obvious characterized by the prefix. Photoluminescence of solids is excited by light itself and and is subdivided into fluorescence and phosphorescence. Thermoluminescence is light from gentle heating. Electroluminescence appears from gases in electrical fields, crystallo-luminescence and triboluminescence occur when solutions crystallize or when crystals are crushed or broken, and chemiluminescence may appear during chemical reaction. All bioluminescence are example of chemiluminescence. Luminescence is a general term to describe the process in which a material absorbs energy from an external source and re-emits that energy in the form of visible light**[1] [2].**

Type of Luminescence:-

Luminescence varies depending on the type of energy that excites the electrons and also the process used to induce luminescence.

A. Energy conversion type luminescence:

Luminescence in which the prefix to luminescence indicates the type of energy being converted into light may be called energy conversion type luminescence.

i. Photoluminescence

ii. Cathadoluminescence

iii. Electroluminescence

iv. Chemiluminescence

v. Bioluminescence

vi. Radioluminescence

B. Stimulation or induction type luminescence:

Luminescence in which the prefix to luminescence does not show the energy which is converted into light, but it indicates the energy or process used to stimulate or induced the luminescence.

i. Thermoluminescence

ii. Mechanoluminescence

iii. Sonoluminescence

iv. Crystalloluminescence

v. Lyoluminescence

vi. Candoluminescence

C. Conceptual type luminescence:

Luminescence in which the prefix neither shows the energy being converted into light, nor stimulation or induction of luminescence, such type of luminescence may be called conceptual type luminescence.

i. Super luminescence

ii. Negative luminescence

iii. Cross luminescence

iv. Anti-stoke luminescence**[4]**

A. Energy conversion type luminescence:

i. Photoluminescence:

Luminescence where the energy is supplied by electromagnetic radiation and this electromagnetic radiation is directly converted into the light energy. Shine light on a luminous watch and it shines back. That is an example of photoluminescence: luminescence made by light **[9].**

ii. Cathadoluminescence:

Luminescence where the energy is supplied by cathode ray energy and this cathode ray energy is converted into the light energy.

iii. Electroluminescence:

Luminescence where the energy is supplied by electrical energy and this electrical energy is converted into the light energy. Electroluminescence, a light accompanying an electric discharge, whether this occurs in rarified gas in a vacuum tube, or in the air, as when silk or fur is rubbed or material is stripped from a roll. It is due to electron bombardment of gas molecules. In more recent terminology the word has been used for light emitted when electrons strike solids or liquids. Examples include how television pictures are formed, or neon lights, the auroras and lightning flashes.

iv. Chemiluminescence:

Luminescence where the energy is supplied by chemical energy and this chemical energy is converted into the light energy. Those glow in the dark plastic tubes sold in amusement parks are examples of chemiluminescence.

v. Bioluminescence:

Bioluminescence is caused by chemical reaction in living things. It is a form of chemiluminescence. Fireflies glow by bioluminescence. Fireflies and glow-worms are the best known example of bioluminescent creatures. They use a complex reaction to make light from a pair of chemicals called luciferin and luciferase stored in their tails. Bioluminescence is a special kind of chemoluminescence that happens inside living things. Squid, schrimp, sardines, plankton, starfish and all kinds of other marine creatures use bioluminescence for communication, camouflage or defense flashing to attract mates or warm off predators for example.

vi. Radioluminescence:

Radioluminescence is caused by nuclear radiation. Radioluminescence, produced in a material by the bombardment of ionizing radiation . Older glow in the dark clocks dials often used paint with a radioactive material and a radio luminescent material etc.

B. Stimulation or induction type luminescence:

(i) Thermoluminescence:

Thermoluminescence is the emission of light on slight heating of substances. It's characteristics of some samples of fluorspar and has been found to be dependent on a previous storage of energy, usually from light radiation, hence it is delayed phosphorescence. Thermoluminescence is a form of luminescence that is exhibited by certain crystalline materials, such as some minerals, when previously absorbed energy from electromagnetic radiation or other ionizing radiation is re-emitted as light upon heating of the material.

(ii) Mechanoluminescence:

Mechanoluminscence is a type of luminescence in which , light is induced by any mechanical actions on solids. In principle mechanoluminescence(ML) is also called triboluminescence, can arise from elastic deformation and plastic deformation aside from fracture during application of mechanical stress on a solids, it has been referred by this phenomena as elastic-deformation luminescence, plastic-deformation luminescence and fracto-luminescence respectively.

(iii) Sololuminescence:

Sololuminescence is a mysterious phenomenon caused when ultrasound waves excite a liquid, creating tiny bubbles which emit light when they collapse.

(iv) Crystalloluminescence:

Crystalloluminescence is a type of luminescence in which light is induced by crystallization of materials.

(v) Lyoluminescence:

Lyoluminescence refers to the emission of light while dissolving a solid into a liquid solvent. It is actually a form of chemoluminescence. The most common lyoluminescent effect is seen when solid samples which have been heavily irradiated by ionizing radiation are dissolved in water.

(vi) Candoluminescence:

Candoluminescence is the term used to describe the light given off by certain materials which have been heated to incandescence and emit light at shorter wavelengths than would be expected for a typical blackbody radiator etc.

C. Conceptual type luminescence:

Luminescence in which, the prefix neither shows the energy being converted into light, nor stimulation or induction of luminescence. Such type of luminescence may be called conceptual-type luminescence.

i. Super luminescence:

In between some energy levels an inverse population arises owing to the luminescence excitation, then the successive luminescence emission and absorption may amplify the emission instead of being absorbed and this is known as super luminescence or amplified luminescence.

ii. Negative luminescence:

Under certain condition in some spectral region, the non equilibrium radiation of the body is less than the thermal emission background and this is termed as negative luminescence.

iii. Cross luminescence:

Cross luminescence is produced by the recombination of electrons in the valence band with the holes created in the outermost core band.

iv. Anti stoke luminescence:

The luminescence, in which the wavelength of emitted radiation is less than the wavelength of exciting radiation is called anti stoke luminescence.

1. Luminescence Materials:

Luminescence materials play pivotal role in application as well as role of development. Materials that generate luminescence are called phosphors. The first phosphor synthesized was an impure barium sulfide with very low luminescence efficiency. A more stable sulphide type phosphor was produced in 1866 by heating zinc oxide in a stream of hydrogen sulphide. In 1887 it became known that these sulphides do not luminescence in a chemically pure state but only when they contain small quantities of activator metal. Later, other materials, such as certain metal oxides, silicates and phosphates were found to luminescence if they were prepared by special procedures. Commercial phosphors are mostly inorganic compounds prepared as powders or thin films.

Important groups of luminescent crystalline solids may be classified in different types.

(i) Compound which luminescence in ”pure” state.
(ii) The alkali halides activated with thallium or other heavy metals.
(iii) ZnS and CdS activated with Cu, Ag, Au, Mn or with an excess of one of their constituents.
(iv) The silicate phosphors, such as Zinc orthosilicate, beryllium, cadmium, magnesium, strontium, barium and manganese silicates.
(v) Oxide phosphors such as self activated ZnO and Al_2O_3 activated with transition metals.

2. Characteristics of luminescence:

For understanding the mechanism and uses of any phenomenon, its characteristics play an important role. The spectrum, the power and the quantum yield of luminescence are some major characteristics. Some other important characteristics of luminescence are as given below **[5].**

(i) Luminescence Power
(ii) Luminescence spectrum
(iii) Excitation spectrum
(iv) Luminescence polarization
(v) Optical indicatrix
(vi) Energy and quantum yields
(vii) Luminescence rise and decay
(viii) Light sun
(ix) Thermal characteristics

5. **Mechanism of luminescence:**

The models used to understand the mechanism of luminescence are configuration coordinate model and energy model. These models are not mutually exclusive, but can one should be used to aid each other to give complementary information when required **[6].**

6. **Application of luminescence:**

Luminescence is a subject that continues to play a major technological role of human mankind. Luminescence is the phenomena in which all or part of absorbed energy is re-emitted in the form of electromagnetic radiation in the visible in the near visible region of the spectrum **[8].** There are a lot of applications of luminescence. Some of the important applications are given below:-

(i) Luminescence sensors detect visible and non visible marks that illuminate when using ultraviolet light.
(ii) Phosphor thermometry, Phosphorescence can be used to detect the temperature of an object for example a gas turbine component.
(iii) Luminescence materials are also used in scintillation counters whereby nucleons can be detected.
(iv) Luminescence materials are used in fabricating X-ray imaging plates, which has presently replaced X- ray photographic films.
(v) Phosphors are used in Fluorescent tubes, energy saving lamps, etc.
(vi) Cathodoluminescence phosphors are used in the screens of television, CRO, Radar,electron microscope and night vision devices.
(vii) Bioluminescent organisms are a target for many areas of research.
(viii) Chemiluminescence ‘glow sticks’ are used as emergency light source.
(ix) Smart mechanoluminescent materials are used as stress, fractures, impact and damage sensors.
(x) Luminescent materials are also used in energy and information storage.
(xi) Luminescent materials are finding important application in opto electronic integrated circuits **[7].**
(xii) Different types of luminescence are used in radiation dosimetry.
(xiii) Thermoluminescence is used in dating of archeological and geological objects.
(xiv) Mechanoluminescence is used in the design of fuse system far war head and also in damage sensors.
(xv) Electroluminescence is used in light amplifier.
(xvi) Radioluminescence are used as a watch dials and standard light source.
(xvii) Thermoluminescent dosimeters(TLD) have become popular in radio diagnosis, nuclear medicine and radiotherapy due to their high sensitivity, low TL fading, reusability and accuracy.
(xviii) To predict earthquake in a particular area or time.

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