International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

An Emerging Research Area of Rare Earth Trivalent Erbium (Er^{3+}) Doped Luminescent Material based Nano Phosphors – A Review

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***Abstract*: -** Trivalent and divalent rare earth elements are contributing to tremendous application areas such as several high-tech, eco-friendly, energy consumed economized display devices. Trivalent Erbium doped efficient host materials are widely used for these applications in telecommunication fibre optical devices. Erbium ions are more stronger covalence bond and lower symmetry. Specifically, strong green light emission was observed under reverse bias due to electron. This present paper reviewed and finding more applications to required studies allowing trivalent Erbium doped silicate based nano phosphor is an interesting alternative high performance, higher reactivity energy consumed optical LED's and display devices.

***Keywords*: -PL, TL, LED's, Akermanite, $Ca_3Al_2Si_6O_{18}$.**

CONSIDERATIONS

Today's scientific findings and invention improved our life ranging from birth to death. Science made significant contributions to improving the quality of human life style via. Technological inventions on individual part in our eco-friendly societies. Sir Isaac Asimov in his book "Chronology of science and discovery", beautifully described how science has shaped the world and human life from discovery of fire to the 21th century. In last few years science taught us how to utilizing our natural resources wisely to maintained their country as well as continuity of humanity. To improved our new brain level of human society science can play a futuristic technical hero. They are many great scientific discoveries and technological achievement in various streams.

Scientists should reflect on the social consequences of the technological applications or dissemination of partial information of their work and explain to the public and truly policy makers the degree of scientific knowledge society in their finding applications. Since 19^{th} century, Science and technology have both complementary part to each other in our people society. At that time to people are truly independent to destroyed nature and cope with environment change. The relationship between the man and the environment has been established in the early periods to conceptual framework for upgrading the technological aspects is also providing foundational scientific developments and recent approaches.

Luminescence is cold emission light source of energy who is the greatest innovative technical research field in new generations. Luminescence phenomenon is not explained in some words but it is clearly described the meaning of light through different languages. Our observation in the colour of the phosphorescence light in a material also excitation spectra of light through scattering. In 19th and early 20th centuries, which was used to heavily doped in different host materials. In luminescence, some energy source kicks an electron of an atom out of transition over (lower-energy) state into (higher-energy) state. We can observe the luminescence phenomenon in nature like, in global-worms, fireflies, and in certain sea bacteria and deep-sea animals [1-4].

Truly described to trivalent and divalent rare earth materials (Eu^{2+}, Eu^{3+}, Ce^{3+}, Tb^{3+}, Dy^{3+}, Er^{3+}) are more precious and valuable long persistent phosphors exhibited through UV and visible light excitation. The trivalent rare earth ions exhibited to the conduction band and transition over trapped to electron possibility. Eu^{2+} is a most common emission centre in persistent material hosted by the $4f^7 \rightarrow 4f^65d^1$ transition [5-6].

The rare earth doped silicate materials have been widely studied and more possibilities such as tremendous high thermal light emission, more stable, more durable, compactness, eco-friendly, energy saving and more luminescent efficient indicating white LED's [7-8].

F block elements are also called Lanthanide elements [La (57) to Lu (71)]. Erbium is the most efficient trivalent rare earth ion and energy level transition of electron of an atom ground state to excited state ($4f^{12}$, $6s^2$).

Since 2011, First time investigated silicate-based bio ceramics for tissue engineering. The conventional combustion process has also studied to synthesized divalent Europium doped Ca_2MgSiO_7 and Sr_2MgSiO_7 have Akermanite structure who shows that high intense emission spectra of Eu^{2+} to glows peak/curves [9].

Since 19th century, increasing research area to keep interest have been focused on the design of high intense emission Erbium doped fibre optics, lasers and optical amplifier display glasses who have developed to high-tech, eco-friendly and more energy efficient optical communication devices [10].

Semiconductors and insulators are the main part of cross relaxation process through different trivalent terbium ion interactions. Phenomenon of Interactions are widely used which have increasing the luminescence intensity and decreases the concentrations. Terbium ion increases the light emission intensity transition between $^5D_4$ (green) shift to $^5D_3$ (blue) shift. This transition reduced by increasing between an excited ion to ground state who have nearest ion of the atom [11].

Trivalent Er^{3+} doped yttrium silicate powders were prepared by combustion synthesis method and the effect of Mg^{2+} on its wavelength emission find that in near infrared region. CW laser excitation wavelength at 532 nm in the visible produced near Infrared emission. Enhancement of Tb^{3+} emission by nonradiative emission of captured electron energy transfer from Dy^{3+} in silicate glass plate [12].

The noble advantage to area of luminescence has shown **"Lanthanide ions as activators"**. Different activators significantly distributing the afterglow properties of phosphors short to long time distance. Host material is largely depending on more efficient and durable emission spectra of lanthanide ions. Tb^{3+} doped ($Ca_3Al_2Si_6O_{18}$) powders corresponding to 4f-4f electronic transitions from states $^5D_3$ (green) and $^5D_4$ (white) of Tb^{3+} were observed wavelength under UV excitation at 355 nm [13-16].

Trivalent Er^{3+} ions around a stronger covalency and lower symmetry. Maccumber theory is based on stimulated (emission from absorption) cross section for $^4I_{13/2}$ to $^4I_{15/2}$ transition. Erbium doped glass displayed intense green and a week red emission under shifted to shorter wavelength 380nm excitation spectra [17].

Trivalent Er^{3+} doped host materials-based fibre optics; glasses, display devices are widely applications like for photonics and laser applications. Some more qualities are replacement and regenerate fibre optics overcome the loss link by laser amplification [17-19].

The study of $Sr_2SiO_4:Eu^{2+}$, Dy^{3+} phosphors was prepared through combustion method. Monoclinic structure and the average crystallite size were calculated as 12.77 nm. The single glow peak which TL glow curves were measured using Chen's glow curve method [20].

Trivalent erbium and terbium ion both are more efficient for observing infrared to visible up conversion and broadband emission at 1.54μm under wavelength 980nm excitation overcome erbium ion transited lower energy state absorption spectra [21-22].

This review paper of research study focused on the synthesis of trivalent erbium doped silicate based micro and nano phosphors, especially (calcium, barium, strontium) silicates synthesis process mechanism to improve the properties of crystal structure, characterization, Glow peak, product features, fibre optical devices much better possibilities. Finding applications are rapid communication optical devices depend conditions by a magnitude of nano sensor materials which performs to unique in percentage of 80-90% to new challenges.

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