I J R B A T, Issue (XI) Vol (II) May 2023 : 55-58
A Double-Blind Peer Reviewed & Refereed Journal
OPEN ACCESS
e-ISSN 2347 – 517X
Original Article
INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY
 www.ijrbat.in

SYNTHESIS AND CHARACTERISATION OF RED LIGHT EMITTING EU^{3+}DOPED $ZNAL_2O_4$PHOSPHORS USED TO INCREASE THE GROWTH AND DEVELOPMENT OF FRUIT AS WELL AS FLOWERING PLANTS BY ENHANCING THEIR PHOTOSYNTHESIS PHENOMENON

Arati Duragkar

Department of Chemistry, SevadalMahila Mahavidyalaya, Nagpur, India
Corresponding Email: aratimduragkar@gmail.com

Communicated : 12.01.2023 | Revision : 16.02.2023 & 23.02.2023 Accepted : 22.03.2023 | Published : 30.05.2023

ABSTRACT:
Red light is extremely effective for the growth and development of plants specially fruits and flowering plants. The plant's green chlorophyll absorbs red light more rapidly than any other colour present in the visible light spectrum. This leads to produce more energy which ultimately uses to grow the plant taller and healthier.
Keeping all the things in mind in the present work, we synthesized $ZnAl_2O_4$inorganic phosphors co-doped with different concentrations of Eu^{3+} which emit red light with high emission intensity, by using solution combustion method. Photoluminescence (PL) emission spectra show intense emission peak at 614nm and the highest emission intensity was observed for $ZnAl_2O_4$: Eu 0.5 mol% phosphor.Thus, the phosphor can be used as red-light emitting phosphor.

Keywords :- Red light, Chlorophyll, $ZnAl_2O_4$: Eu 0.5 mol%, Solution combustion method, Photoluminescence.

INTRODUCTION :

Production of plants using artificial lighting instead of sunlight are known as plant factories.This concept was put forward, improved and adapted in Japan during the 1980s. In 1990s, the products obtained from such factories attained high evaluations by the food service industry.Then during 2000s this method was also used for the commercial production of nursery plants of fruits and vegetables, medicinal plants as well as genetically modified crops and till the late 2000s, plant factory technology has been initiated worldwide, especially in Asian countries[1].In late 2000s, light-emitting diodes (LEDs) were introduced as a more efficient light source in plant factoriessupposed to reduce the electricity costs of lighting & cooling as compared toconventional light sources [2]. LEDs having advantages such as its high-brightness, easy to adjust, long-lifetime and high spectral matchinghence they become the plant factory light sources with red and blue LED chips and phosphor-convertor LEDs [3,4].Red light-emitting diodes (LEDs) are eminent light source for growing plants because of their safety, small mass and volume, wavelength specificity, and longevity[4]. Red LEDs emit a narrow spectrum of light that is close to the maximum absorbance for both chlorophyll and phytochromes. Red LEDs have great potential for use as a light source to promote photosynthesis[5, 6].

In this work, different concentrations of Eu^{3+} doped $ZnAl_2O_4$ phosphors with well chemical and physical stable performance were synthesized, where the photoluminescence study of these samples revealed that the phosphors can be excited by blue and emit red light.

MATERIALS AND METHODS :

The different concentrations of Eu^{3+} doped $ZnAl_2O_4$ inorganic phosphors were synthesized by solution combustion method. The A.R grade chemicals. Aluminum nitrate [Al $(NO_3)_3$], Zinc Nitrate [Zn $(NO_3)_2$], and urea was used without

http://doi.org/10.29369/ijrbat.2023.02.1.0009

further purification. All the chemical in stoichiometric ratio dissolved in minimum quantity of water and mix the content in China dish then heated in pre-heated vertical muffle furnace at 600^{0}C, where auto combustion took place accompanied with evolution of brown flames. After completion of combustion process the white solid material was obtained. After cooling his material, we crushed it in fine power using mortar and pestle. In the same manner by adding different concentration ofEu in the form of Eu_2O_3(which was dissolved in minimum quantity of conc. Nitric acid). The prepared inorganic phosphors were used for further spectroscopic characterization.

RESULT AND DISCUSSION :

The PL properties of $ZnAl_2O_4$: Eu^{3+}(0.1,0.3,0.5,0.7 and 1 mol%) were further investigated by the PL excitation and emission spectra as shown in Fig.1 and 2. The excitation spectrum was obtained at emission wavelength 614 nm where various sexcitation peaks of Eu^{3+}observed between 350 nm and 470 nm. In addition to that prominent excitation peaks are observed at 395 nm and 465 nm which are due to the f-ftransitions of Eu^{3+}. The highest excitation peakis in the blue region observed at 465 nm in the UV region due to $^7F_0 \rightarrow {}^5D_2$ (465 nm) transition.

Upon excitation at 465 nm, the emission spectra have shown the characteristic transition lines from the excited D_0 level of Eu^{3+}ions.

Onexcitingit at 465 nm, the PL emission spectra shown the characteristics transitionlines from the excited D_0 level of Eu^{3+}ions. Two emission peaks are observed at 578nm and 614nm due to $^5D_0 \rightarrow {}^7F_1$and $^5D_0 \rightarrow {}^7F_2$ transitions respectively as shown in fig 2. Transitionat 614 nmdueto $^5D_0 \rightarrow {}^7F_2$ is more efficient emission hence is adominant peak which lies at the orange-red region.

CONCLUSION :

$ZnAl_2O_4$ compound doped with different concentrations of Eu^{3+} ions were successfully synthesized by solution combustion method of synthesis. Phosphor shows strong emission at 578nm and 614nm when monitored at 465 nm excitation wavelength which belongs to orange - red region. The highest emission intensity is observed for $ZnAl_2O_4$: Eu 0.5 mol% phosphor. Hence $ZnAl_2O_4$: Eu 0.5 mol% phosphor was proposed as one of the red components for white light emitting diode phosphor.

$ZnAl_2O_4$: Eu 0.5 mol% phosphor can be eminently used as a red emitting diode to enhance the growth of fruit and flowering plants.

REFERENCES:

E. Goto(2012) Plant Production in a Closed Plant Factory with Artificial Lighting,ISHS ActaHorticulturae 956: VII International Symposium on Light in Horticultural Systems.

Hideo Yoshida, Daiki Mizuta, Naoya Fukuda, Shoko Hikosaka (2016) Effects of varying light quality from single-peak blue and red light-emitting diodes during nursery period on flowering, photosynthesis, growth, and fruit yield of everbearing strawberry,Plant Biotechnology 33, 267–276 DOI: 10.5511/plantbiotechnology.16.0216a

Y. H. Kim, P. Arunkumar, B. Y. Kim, S. Unithrattil, E. Kim, S. H. Moon, J. Y. Hyun, K. H. Kim, D. Lee, J. S. Lee, W. B. Im, (2017) A zero-thermal-quenching phosphor, Nat. Mater.16 ,543- 550.

O. Długosz-Grochowska, A. Kołton, R. Wojciechowska(2016) Modifying folate and polyphenol concentrations in Lamb's lettuce by the use of LED supplemental lighting during cultivation in greenhouses, J. Funct. Food 26, 228-237.

http://doi.org/10.29369/ijrbat.2023.02.1.0009

G.D. Goins, N.C. Yorio, M.M. Sanwoand C.S. Brown (1997)Photomorphogenesis, photosynthesis, and seed yield of wheat plants grown under red light-emitting diodes (LEDs) with and without supplemental blue lighting Journal of Experimental Botany, Vol. 48, No. 312, pp. 1407-1413.[6] Keodrick RE, Kronenberg GHM. 1994. Photomorphogenesis in plants, 2nd edn. The Netherlands: KJuwer Academic Publishers.

http://doi.org/10.29369/ijrbat.2023.02.1.0009

Fig.1 Excitation spectra of $ZnAl_2O_4$: Eu^{3+} phosphor at 614 nm emission wavelength

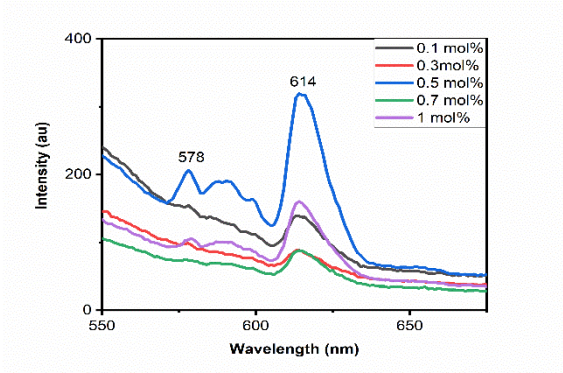
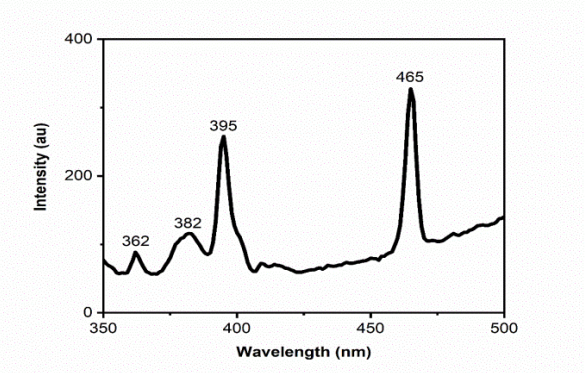


Fig.2 Emission spectra of $ZnAl_2O_4$: Eu^{3+} phosphors at 465 nm excitation wavelength



http://doi.org/10.29369/ijrbat.2023.02.1.0009