Inorganic Phosphors For Solid State Lighting

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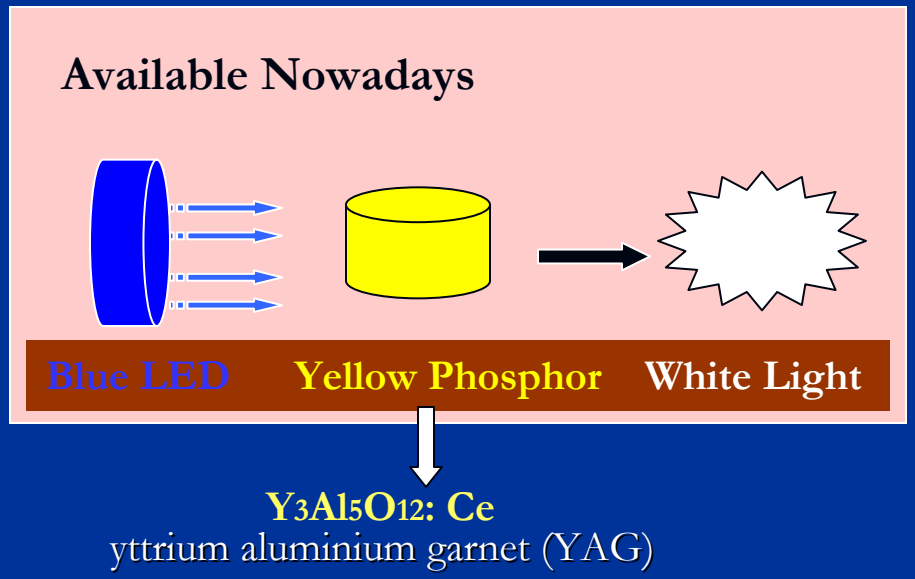
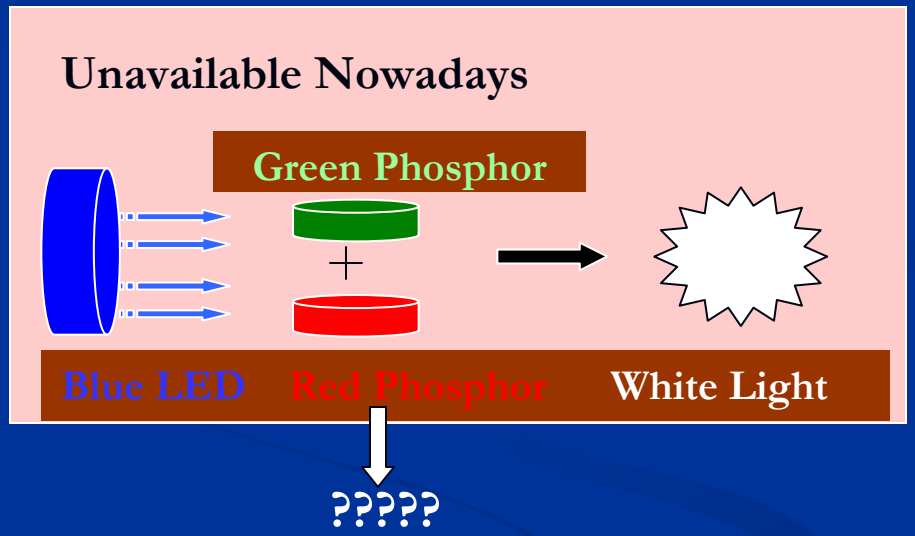
Introduction

- Light emitting diode (LED) based lighting- efficient for white light.
- High luminous efficacy without consuming large amount of energy.
- White light is composed of blue, green and red colors.

Strategies to obtain white light





Goals

- Investigate new red phosphor that could be excited using the blue LED- $Y_3Al_5O_{12}$:Ce+Cr

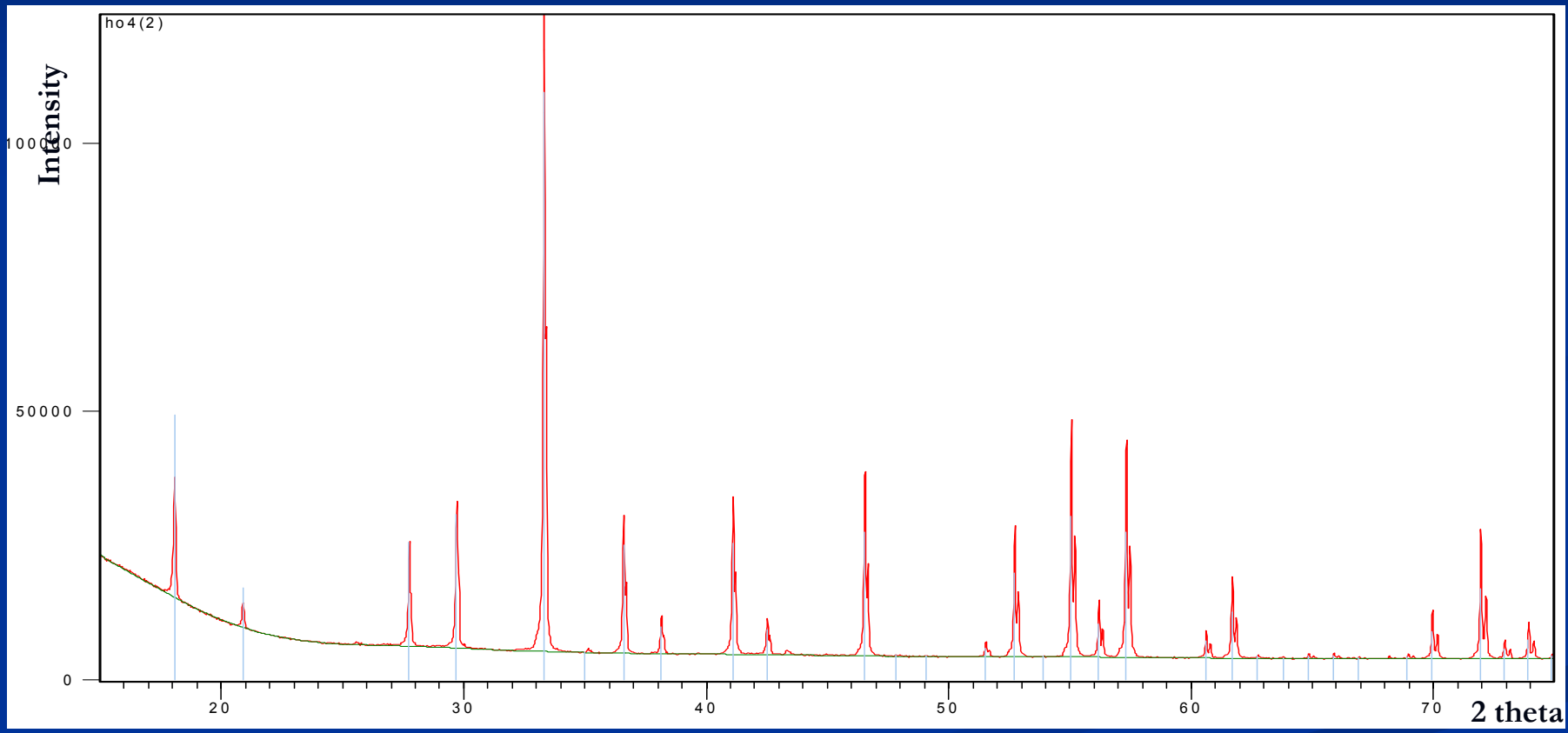
Experimental Procedure for YAG

Photoluminescence Spectrometer

Experimental Data

Powder X-Ray Diffraction

$Y_3Al_5O_{12}$: Ce(2%), Cr(2%)- heated at 1500°C for 2 hours.

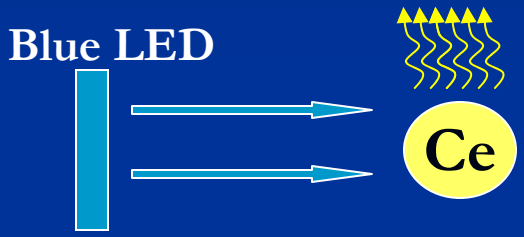


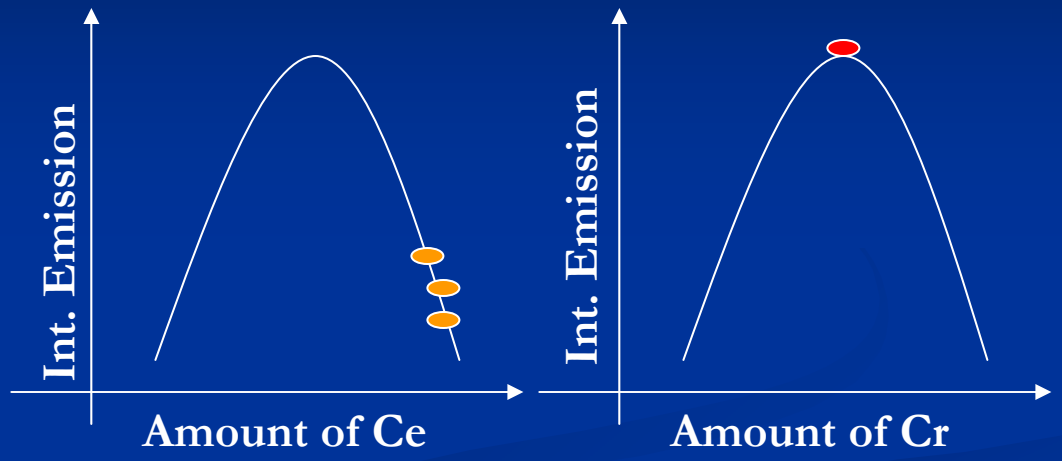
- The above matched the standard X-ray diffraction pattern of cubic-$Y_3Al_5O_{12}$. Optimal heating temperature was 1500°C for all reactions.
- Impurities of starting materials present when heating temperature was low.

Photoluminescence Measurements

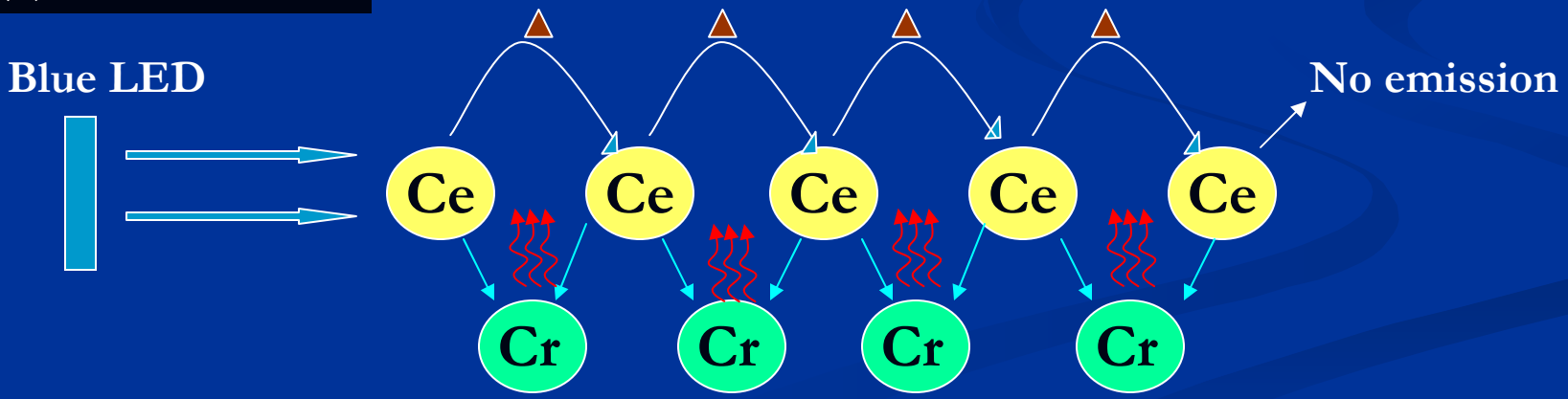
Schematic

(1) YAG : Ce





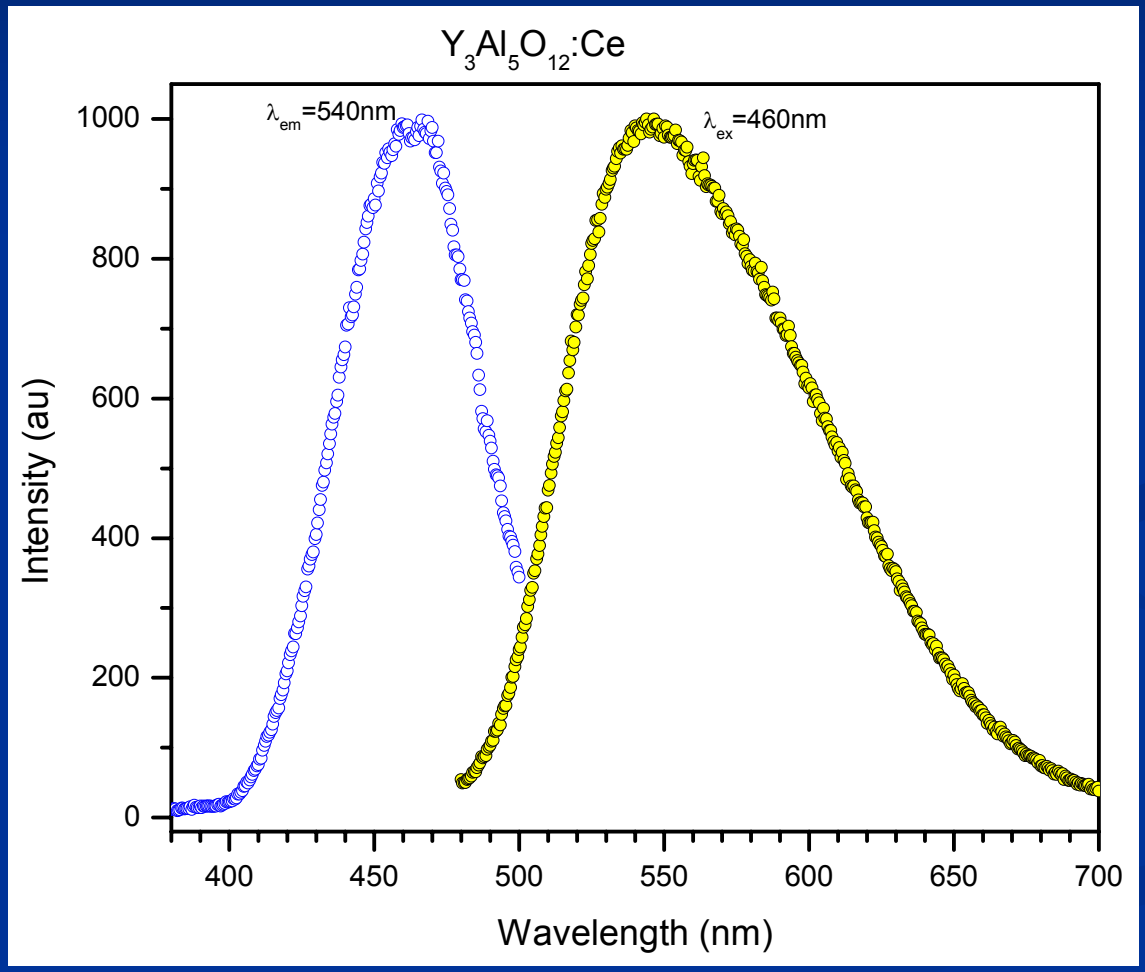
(2) YAG: Ce, Cr



The concentration of the Ce increased that caused quenching of the luminescence.

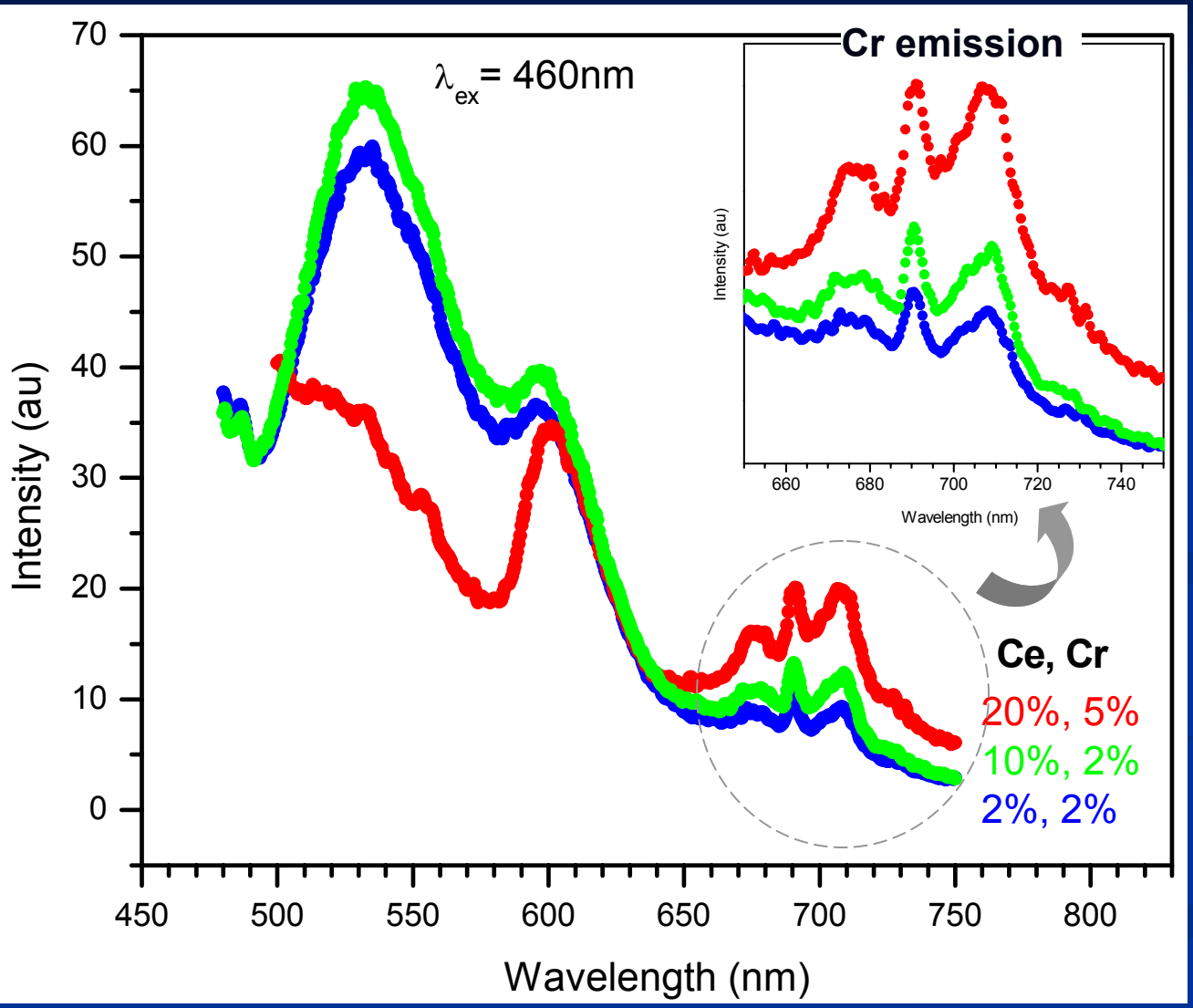
Graphs for Photoluminescence Measurement

Luminescence of YAG doped with Ce



- Optimal excitation of Ce at 460nm
- Emission centered at 540nm
- Matches with standard spectrum

Luminescence studies on YAG doped with different amounts of Ce and Cr



- Ce absorbs blue excitation and transfers part to Cr
- Ce % ↑, yellow emission ↓
- Cr % ↑, red emission ↑ (upto 10% Cr)
- When Ce>20%, no pure phase obtained.
- When Cr=10%, quenching Observed.

Summary

- Synthesized pure samples of YAG:Ce+Cr
- Determined that energy transfer occurs between Ce and Cr
- Reduced the Ce emission (540nm) by luminescence quenching
- Increased Cr emission (700nm)

Further work…

- Improve the efficiency of energy transfer (intensity of Cr peak) by attempting synthesis of $Gd_3Al_5O_{12}$:Ce+Cr
- Look for green phosphor that could be excited by blue LED

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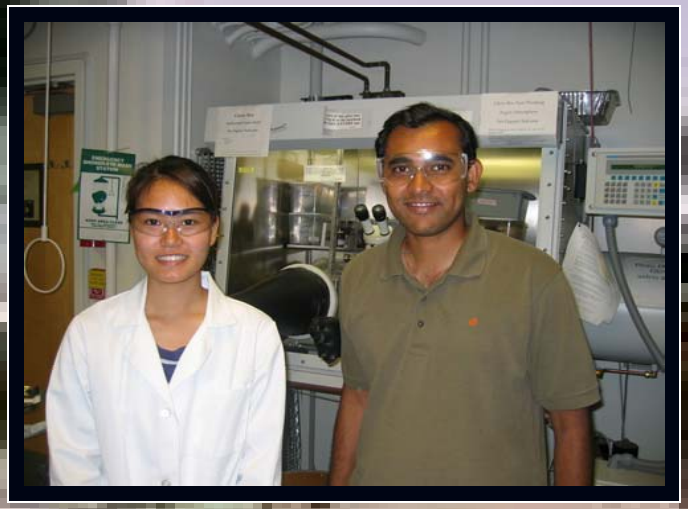


Question ????

Thank You for your kind attention!

What is LED?

Definition

•GaN-based diodes emit bright violet-blue light, which can be used to pump longer wavelength phosphors to obtain white light emitting diodes(LEDs).

•Blue LED is a GaN-based light emitting diodes.

•Developed by Prof. Shuji Nakamura who works in UCSB now.

Application for Blue LEDs?

- Traffic light
- Medical instruments.
- Displays
- Headlight of cars
- TV displays

Advantages for using Blue LEDs?

- Absolutely save more energy than compact fluorescent lamp, incandescent lamp and high-pressure sodium lamp.
- Save energy, Save money!
- Good color rendering for object.

Materials for YAG

(1)$Y_3Al_5O_{12}$

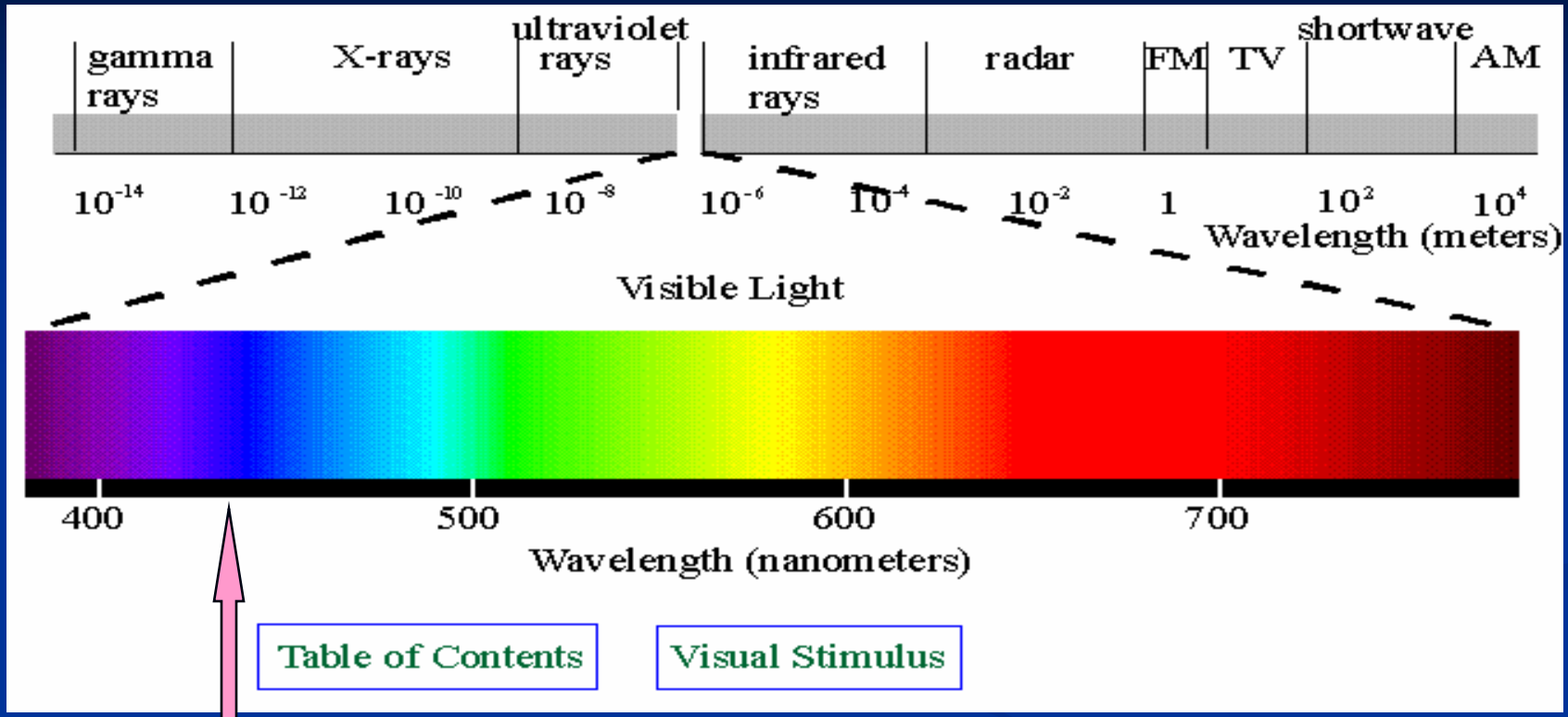
$Y_2O_3 + Al_2O_3$

(2) $Y_3Al_5O_{12}$: Ce

$Y_2O_3 + Al_2O_3 + CeO_2$

(3) $Y_3Al_5O_{12}$: Ce, Cr

$Y_2O_3 + Al_2O_3 + CeO_2 + Cr_2O_3$



460nm for Blue LED

Crystal-field splitting for Ce^{3+}