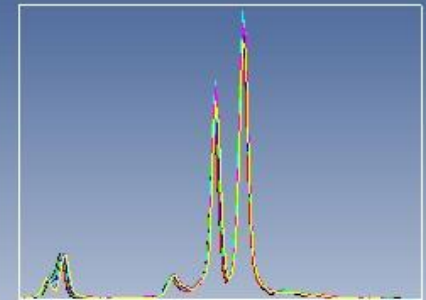
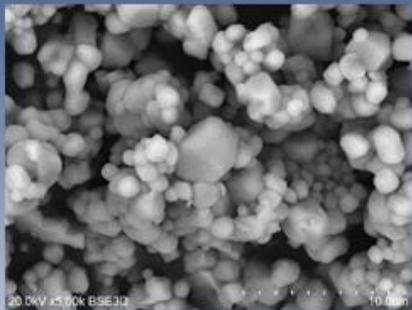


Radio- and Photoluminescence of Mixed Vanadates $\text{Lu}_x\text{Y}_{1-x}\text{VO}_4:\text{Eu}^{3+}$



Viktoriiia Levushkina

Institute of Physics
University of Tartu

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Outline

- Motivation
- Synthesis
- Morphology: SEM
- Crystal structure: XRD
- Radioluminescence
- Photoluminescence
- Conclusions

Subject of study: vanadates mixed crystals
undoped $\text{Lu}_x\text{Y}_{1-x}\text{VO}_4$ and doped with Eu^{3+}

Properties:

- Intensive emission in red\blue range
- Chemical and radiation stability
- High stopping power due to **high density:**
(LuVO_4 - 6.23g/cm^3 , YVO_4 - 4.2 g/cm^3)



scintillators

Applications:

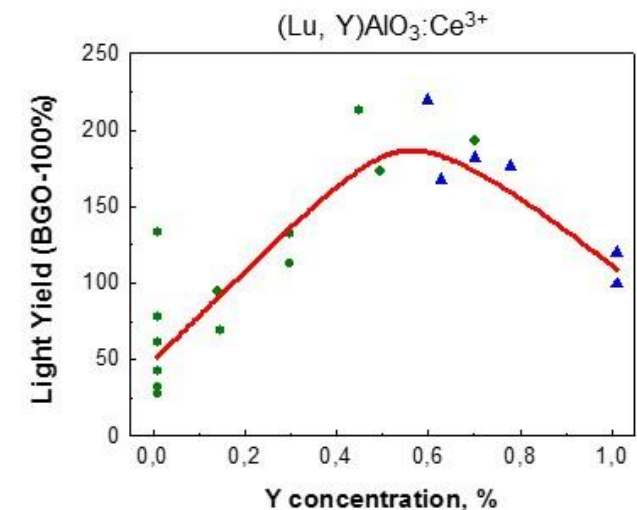
- $\text{YVO}_4:\text{Nd}^{3+}$ laser material
- $\text{YVO}_4:\text{Eu}^{3+}$ fluorescent lamps, plasma display panels

Subject of study:

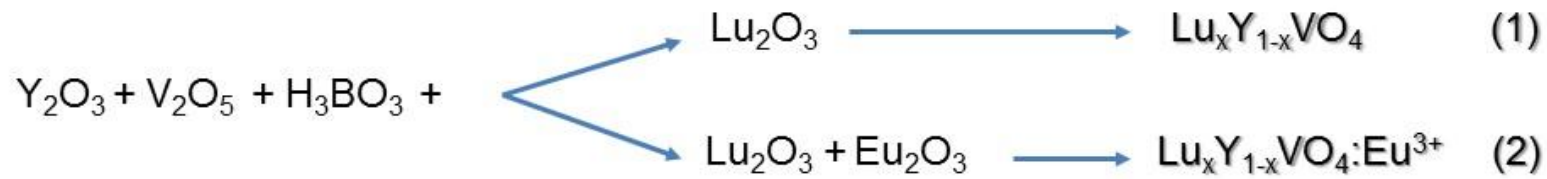
vanadates mixed crystals
undoped $\text{Lu}_x\text{Y}_{1-x}\text{VO}_4$ and doped with Eu^{3+}

Properties:

Developing of a mixed crystals based on YVO_4 can improve its luminescence properties due to a non-linear effect of the increase of the efficiency of excitation energy conversion into luminescence, which also lead to an increase of the scintillation light yield



Solid state method:



Annealing:

- (i) three times at 1000 °C, 1000 °C and 1200 °C for 2 hours with intermediate grindings
 - (ii) only once at 1200°C for 2 hours.
- (x=0, 0.1, 0.3, 0.5, 0.7, 0.9, 1)

With increase of x the powders get more yellow color

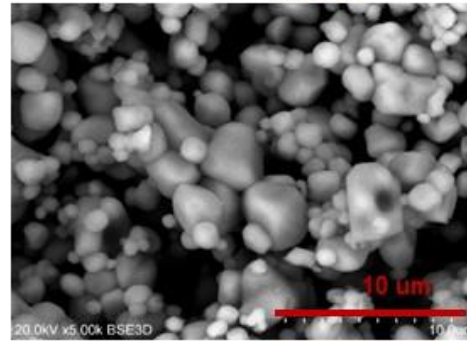


SEM images

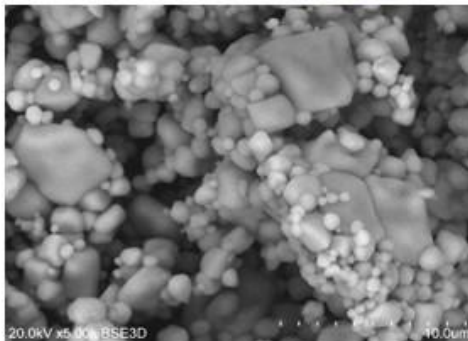
X=0.1



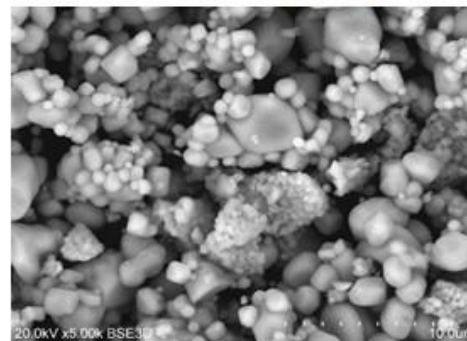
X=0.3



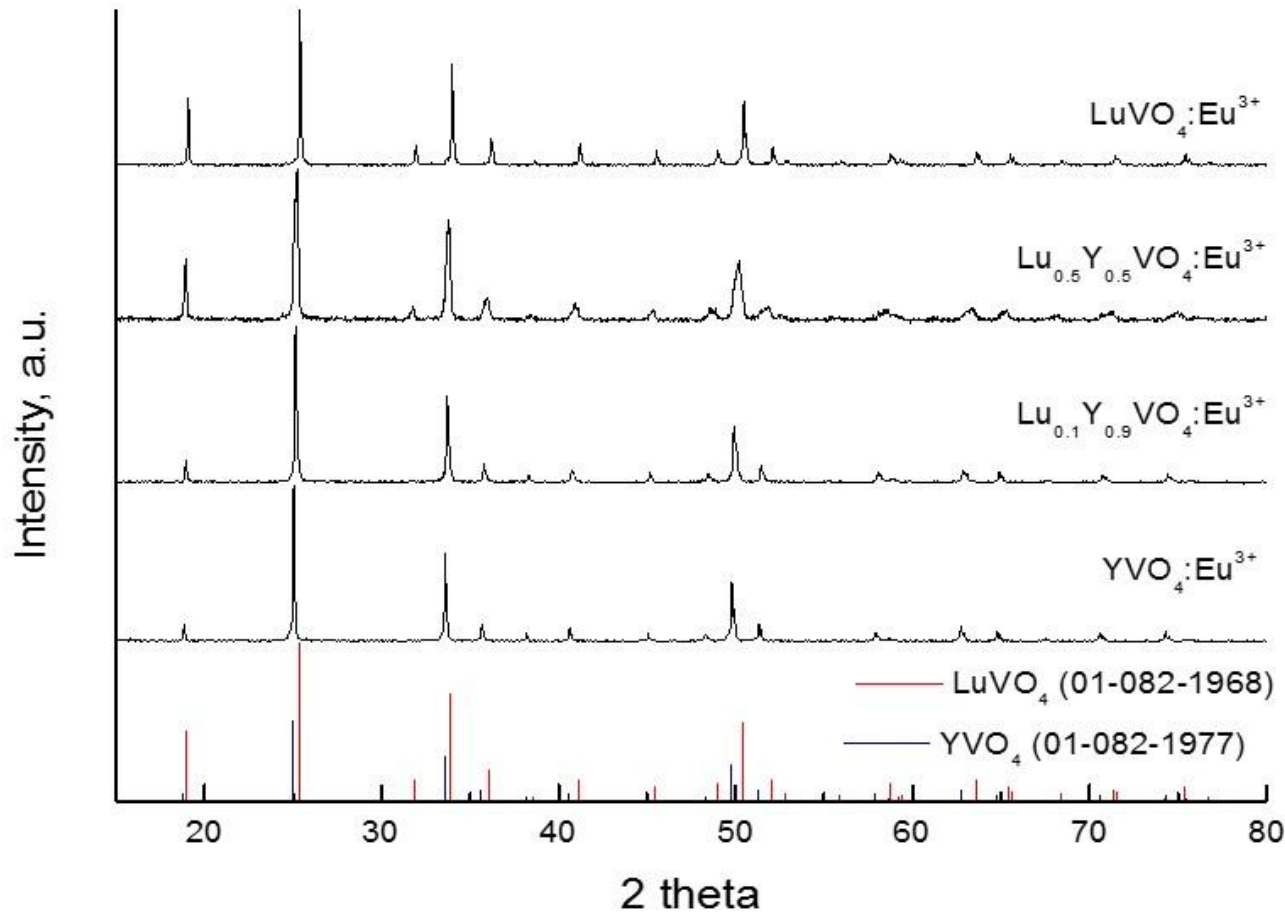
X=0.7



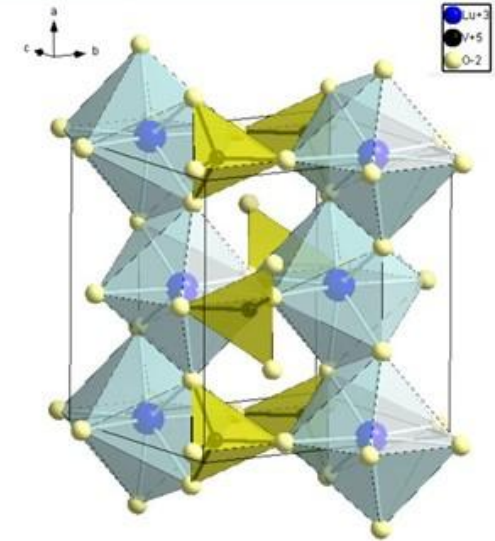
X=0.9



- Size of particles is in the range from hundreds of nanometers to several microns.
- The particles are agglomerated
- no changes in the particle's morphology



XRD patterns of the $\text{Lu}_x\text{Y}_{1-x}\text{VO}_4:\text{Eu}^{3+}$ after 1000 °C, 1000 °C, 2 hours, air.

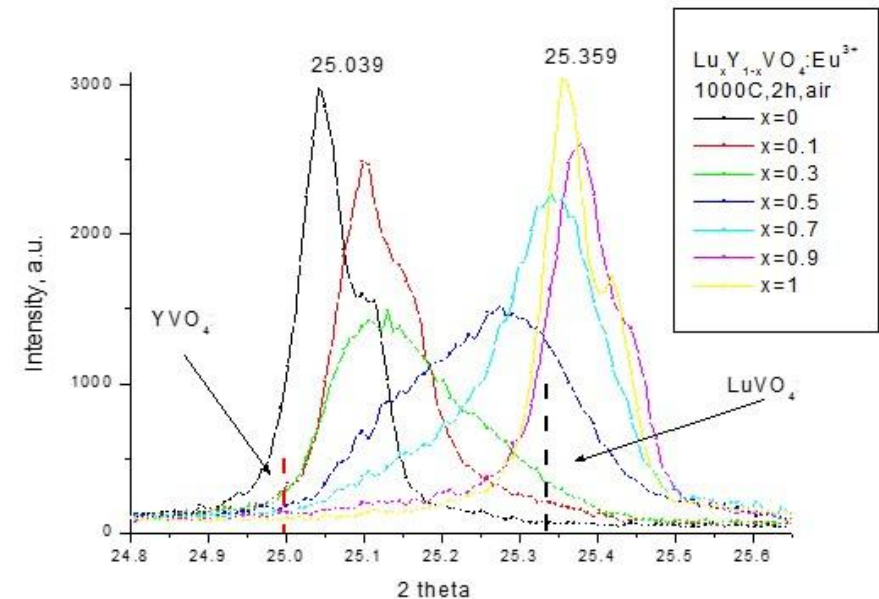


- Tetragonal zircon structure (space group symmetry I41/amd)
- Diffraction line have shifted due to different radii of the Lu^{3+} (0.89 nm) and Y^{3+} (1.02 nm).
- Doping by 1wt%:Eu³⁺ does not create extra phase

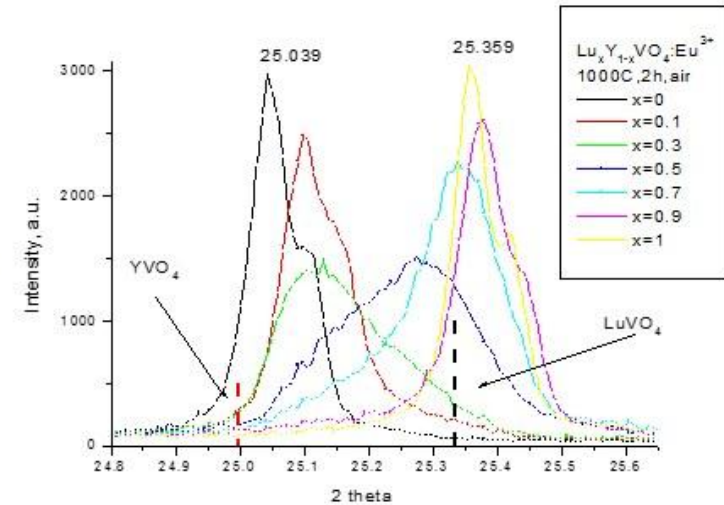
Decreasing of the intensity and broadening of the diffraction peaks in the mixed crystals indicate an increasing disorder of their crystal structure



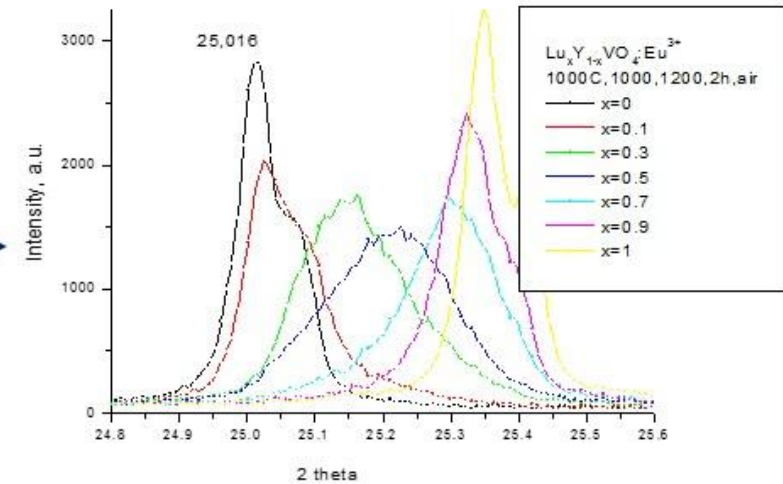
This is the result of significant difference between ion radii of Lu^{3+} and Y^{3+} , which also results in the lattice distortion and induces of a local nonuniform strain in the vicinity of the substituted cation.

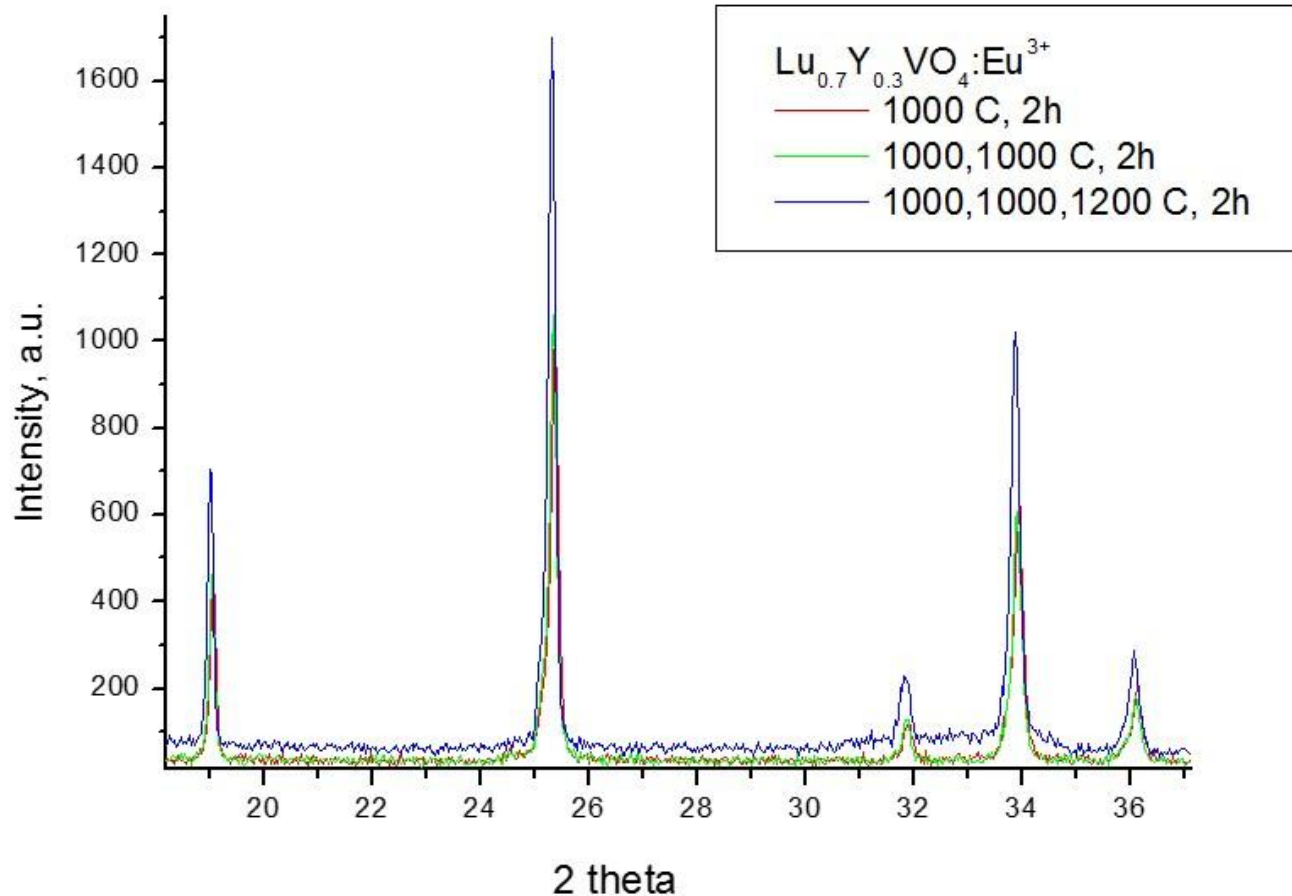


After annealing at 1000 °C, 2 h



Most symmetric XRD lines were detected in the mixed crystals after annealing at 1200 °C that indicates the **enhancement of their crystallinity.**





After each subsequent annealing (**1000, 1000, 1200 °C**) the intensity of the diffraction line increased that indicate an **enhancement of the crystallinity** of the studied mixed crystals.

Position of XRD peaks

+

Bragg's Law

$$\lambda = 2d \sin \theta$$

+

$$\frac{1}{d^2} = \frac{h^2 + k^2}{a^2} + \frac{l^2}{c^2}$$

h,k,l - Miller indices



Experimental lattice constants

YVO₄: a=b=7.11 Å, c=6.30 Å

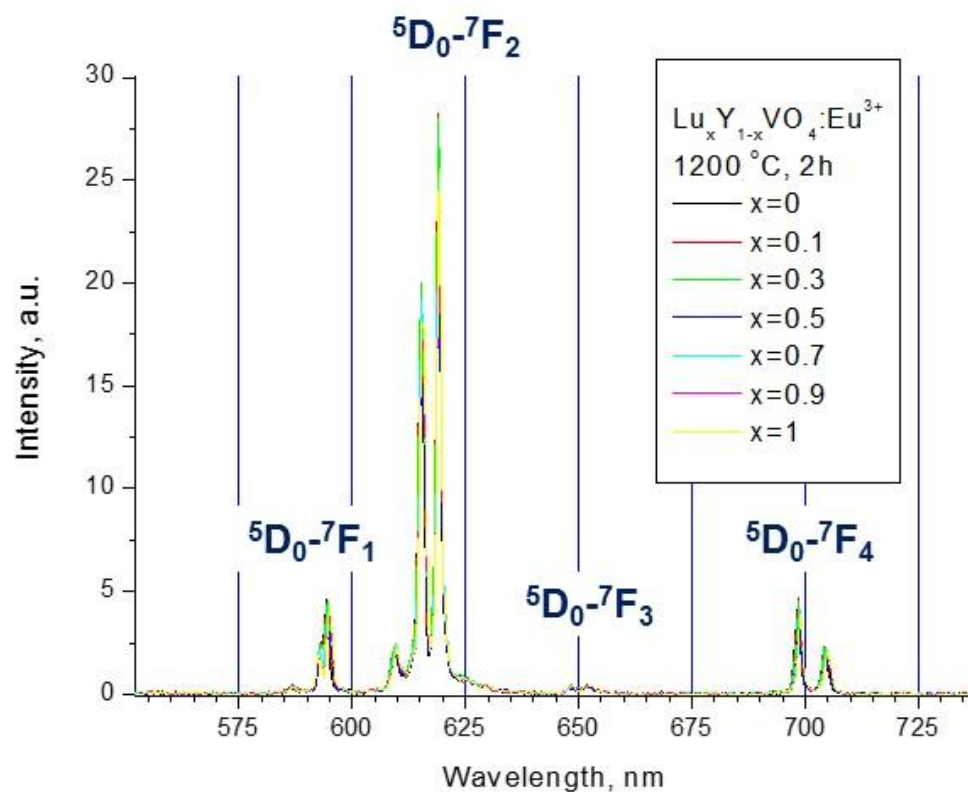
LuVO₄: a=b=7.01 Å, c=6.25 Å



Published data

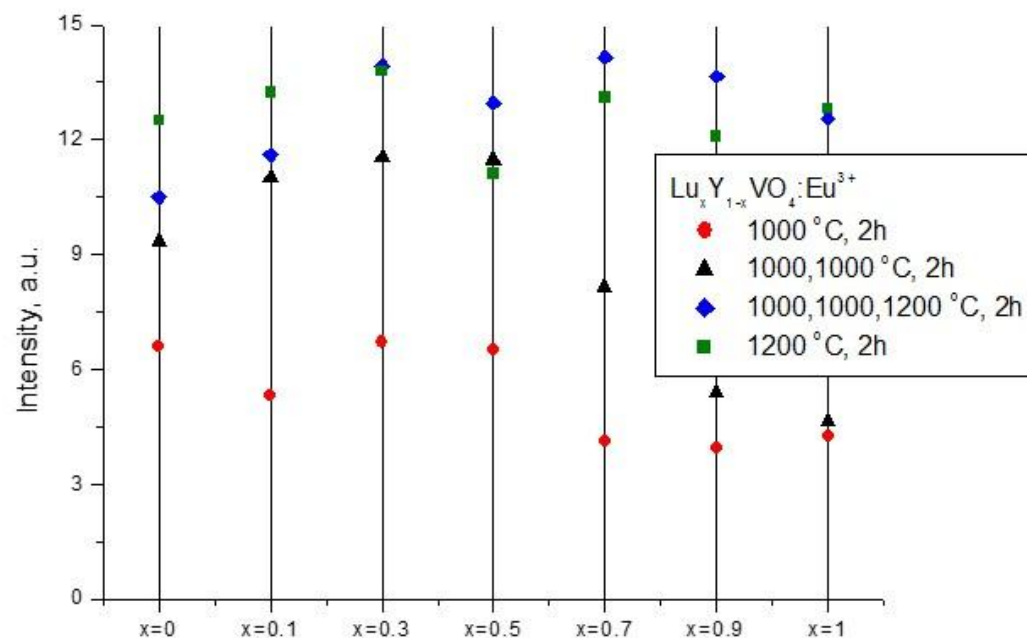
YVO₄: a=b=7.12 Å, c=6.29 Å

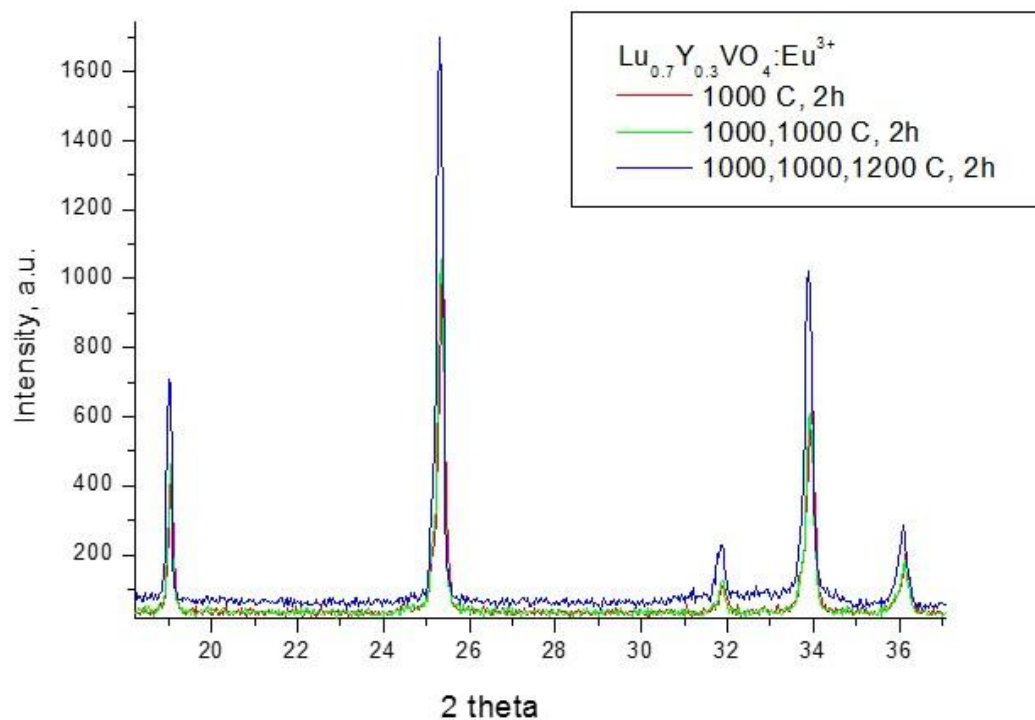
LuVO₄: a=b=7.03 Å, c=6.23 Å



No changes in the shape of the spectra

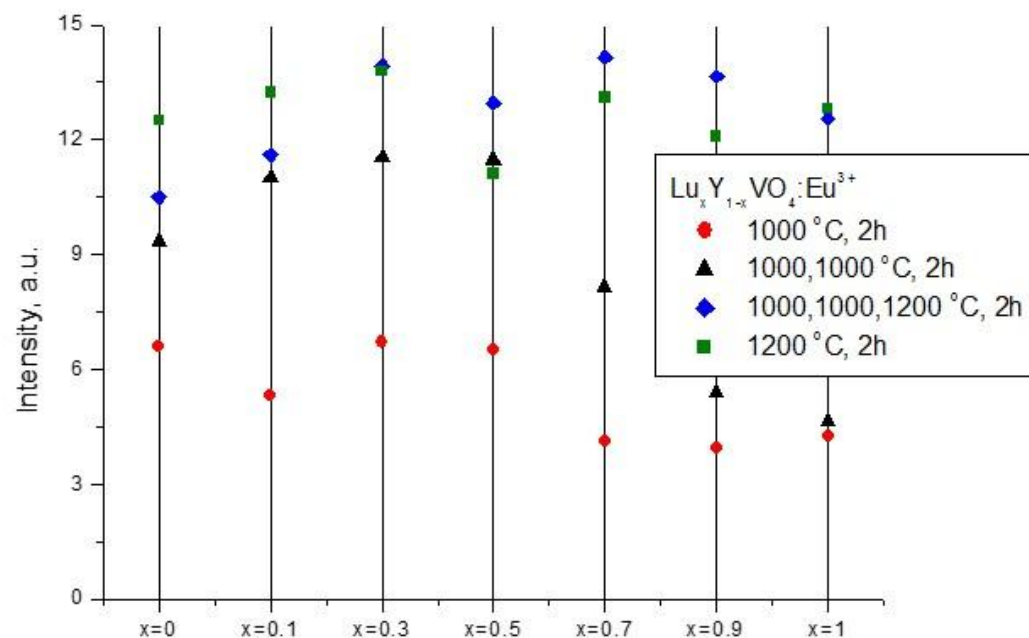
Relative intensity of radioluminescence



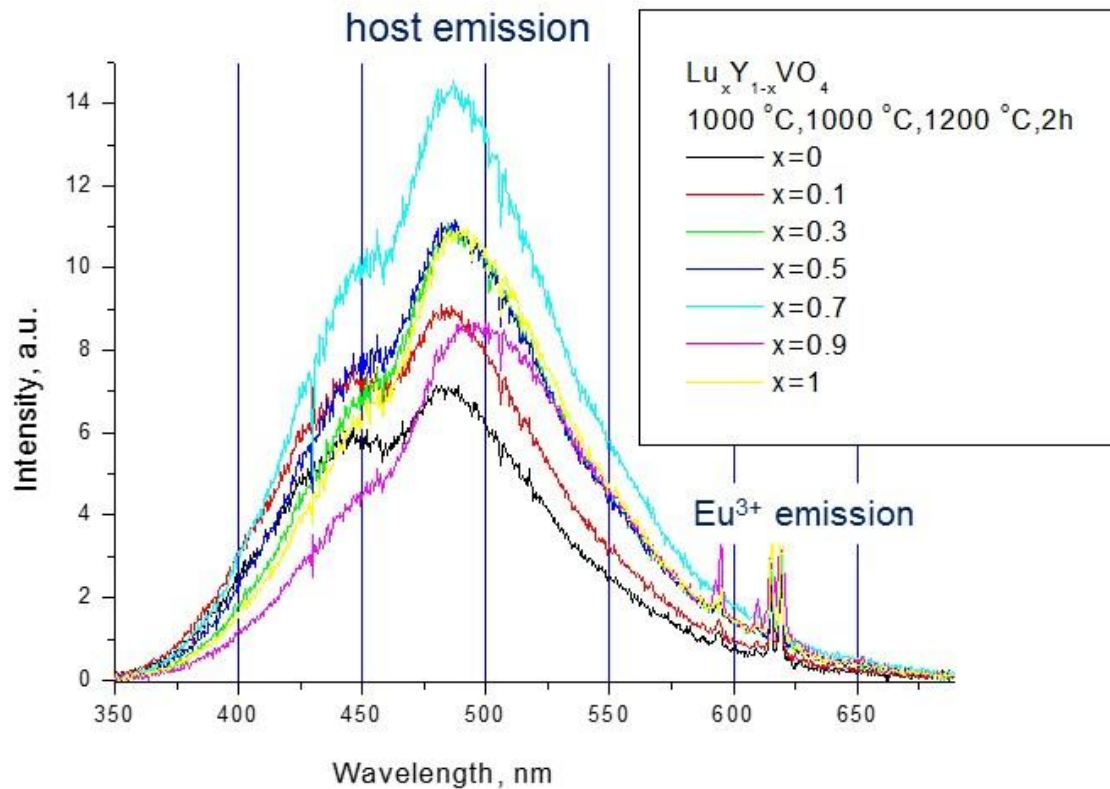


Enhancement of crystallinity results in

Relative intensity of radioluminescence

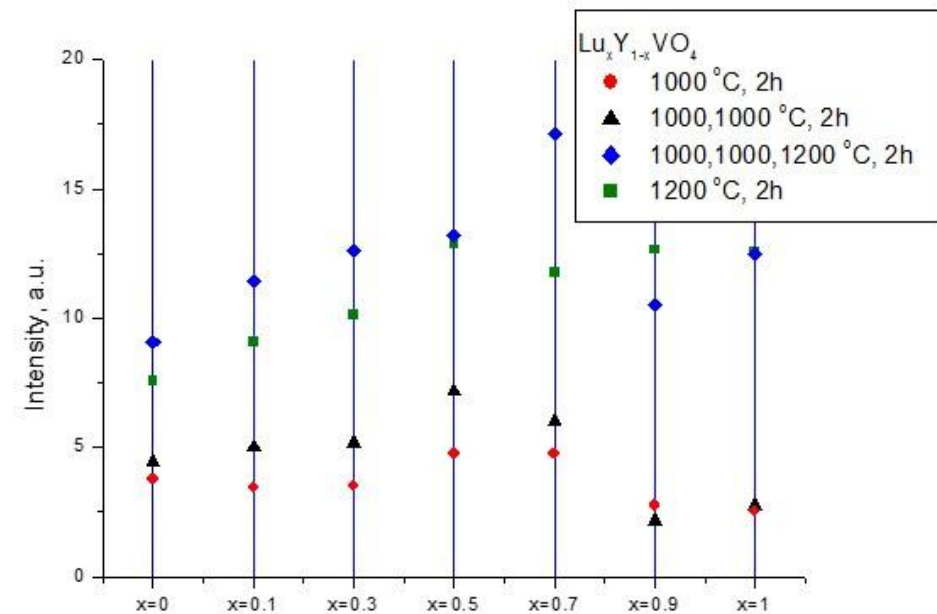


the increase the of luminescence intensity

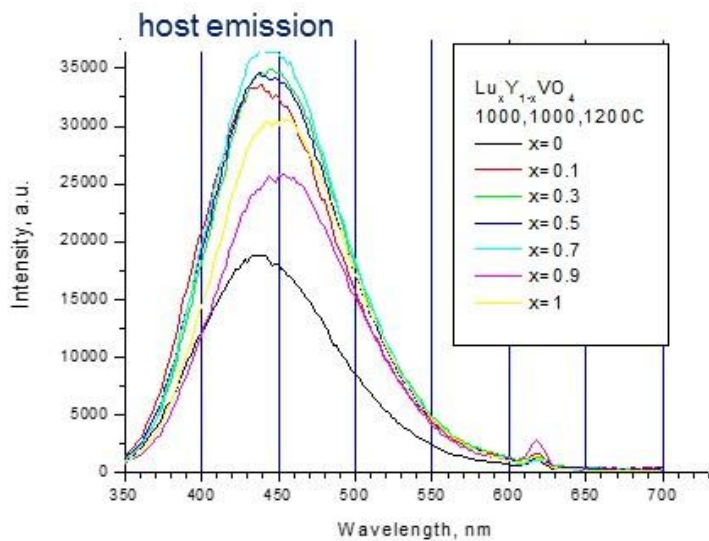
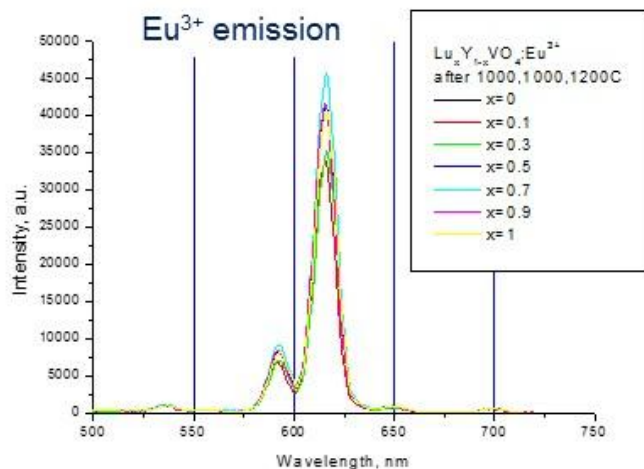


Spectra have not been corrected for instrument function
 (the real shape is one broad smooth band)

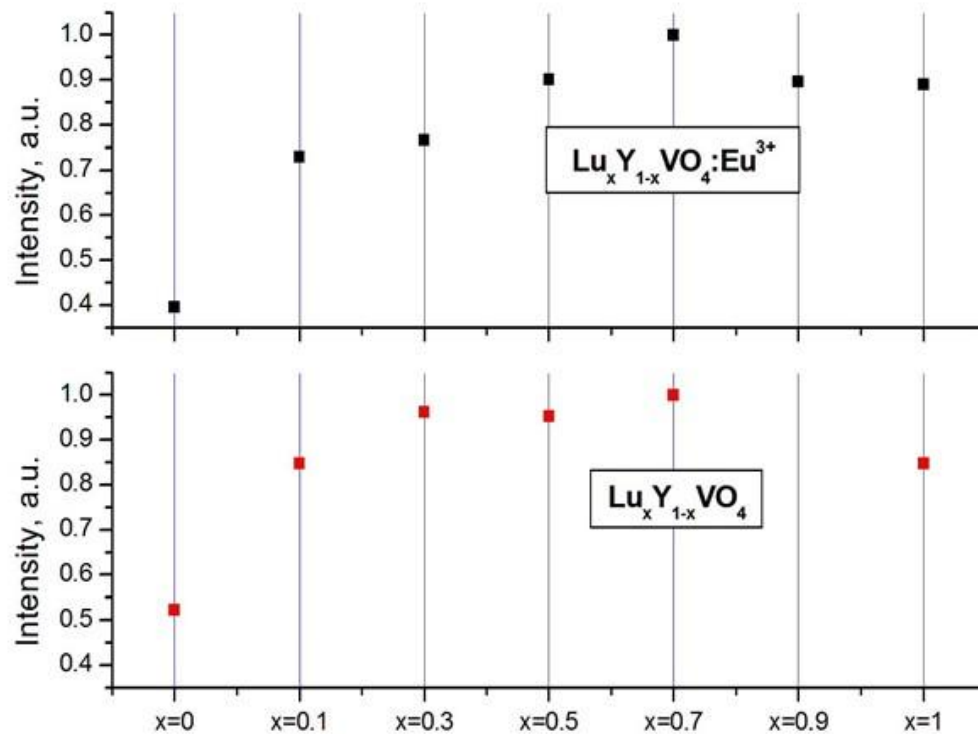
Relative intensity of radioluminescence



Each subsequent annealing increases and
 changes the relative distribution of
the luminescence intensity

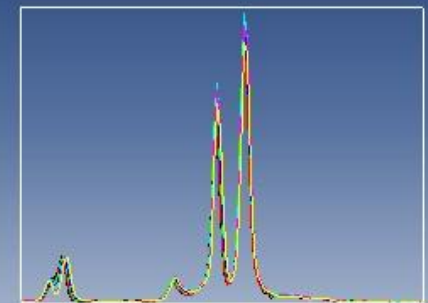
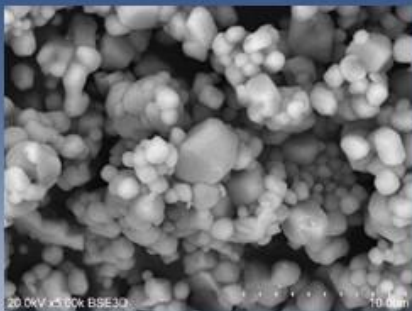


Relative intensity of photoluminescence



- The mixed crystals of $\text{Lu}_x\text{Y}_{1-x}\text{VO}_4$, undoped and doped with Eu^{3+} were synthesized by the solid state method.
- The morphology of synthesized samples was studied by SEM. The particles are agglomerated and their size is in the range from hundreds of nanometers to several microns.
- The crystallinity and phase composition was checked by the XRD method. Tetragonal zircon-type monophase composition has been detected for the undoped and Eu^{3+} - doped mixed crystals. The crystallinity of samples depend on the annealing procedure (temperature and number of annealings). Annealing procedure has been optimized in order to obtain the mixed crystals with better crystallinity and enhanced luminescence intensity.
- The increase of the relative intensity of the both radio- and photoluminescence was detected for the intermediate values of x. Most intensive emission was observed for the undoped as well as for the Eu^{3+} doped mixed crystals with $x=0.7$, which were annealed for three times at 1000 °C, 1000 °C, and 1200 °C.

Thank you for attention!



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