

# Synthesis, structure and luminescent properties of the $K_3Tb(PO_4)_2$ crystals



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## Motivation

The  $Tb^{3+}$  - containing materials are well-recognized phosphors for cathode ray tubes, fluorescence lamps, light-emitting diodes, field emission displays, etc. The plenty of  $Tb^{3+}$  ions emission lines in visible photoluminescence (PL) spectra is related to  $f-f$  transitions from  $^5D_4$  excited level of these ions [ 1- 4].

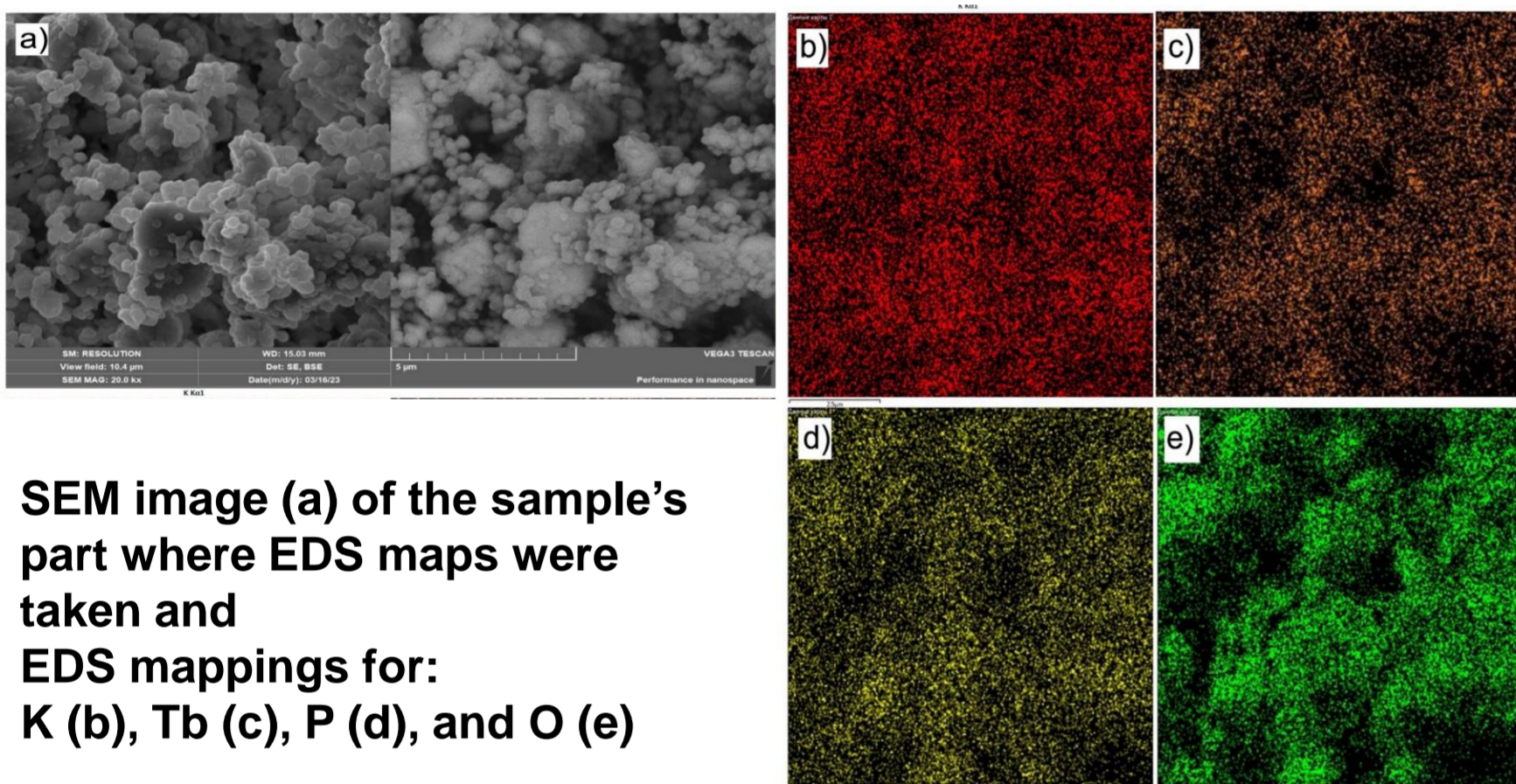
This luminescence can be excited in the ultraviolet (UV) and vacuum UV spectral regions where fundamental absorption bands caused by molecular phosphate anions as well as charge transfer absorption bands are located. The possibility of luminescence excitation both through the host and the  $Tb^{3+}$  ions absorption allows obtaining a phosphor with an adjustable visible emission.

## Samples and Methods

Diffuse reflectance spectra were measured using a Varian Cary 5000 UV-Vis-NIR spectrophotometer with a DRA-2500 external diffuse reflectance accessory. Photoluminescence (PL) spectra were measured at RT using a Horiba/Jobin Yvon Fluorolog-3 spectrofluorometer equipped with 450 W xenon lamp and DFS-12 spectrometer with diode-pumped lasers used for the PL excitation.

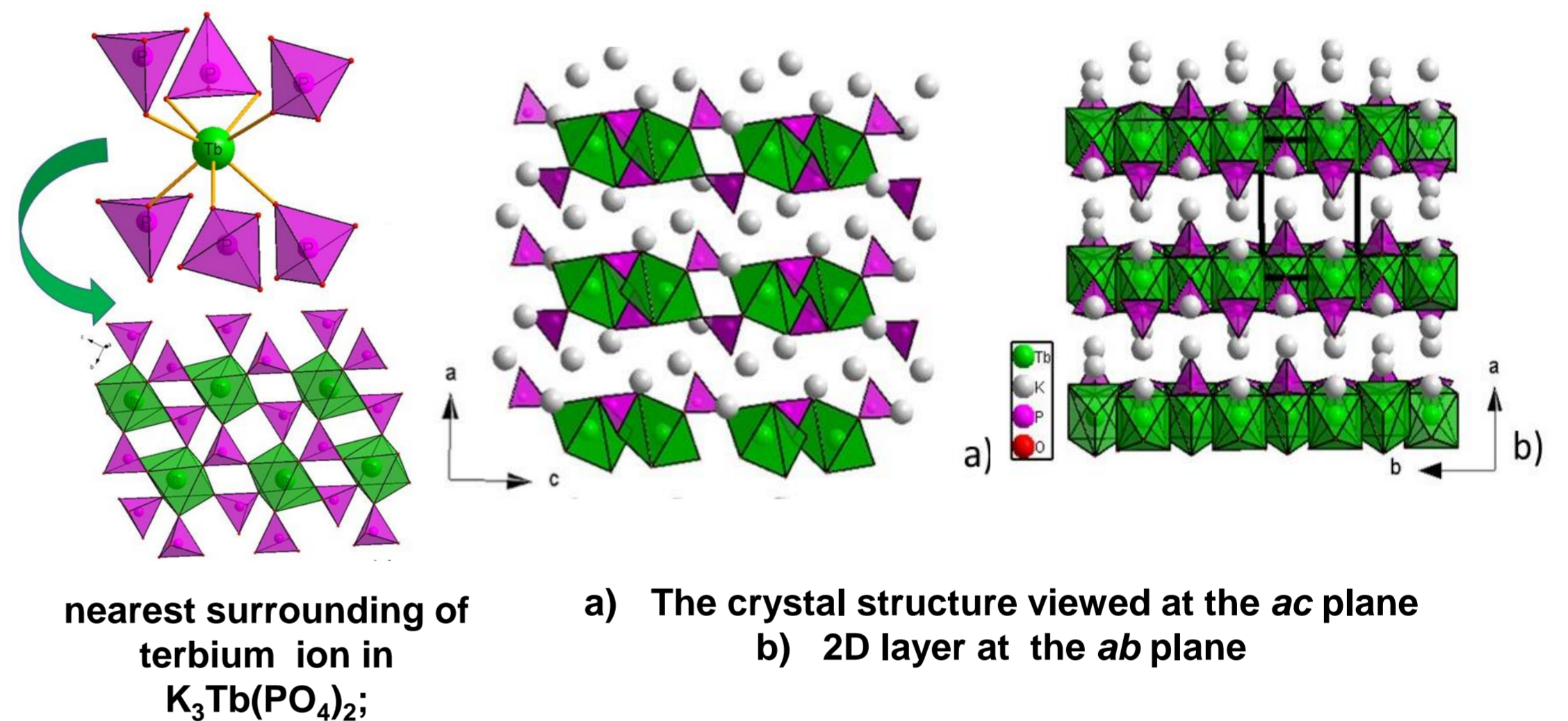
## Results

### Morphology

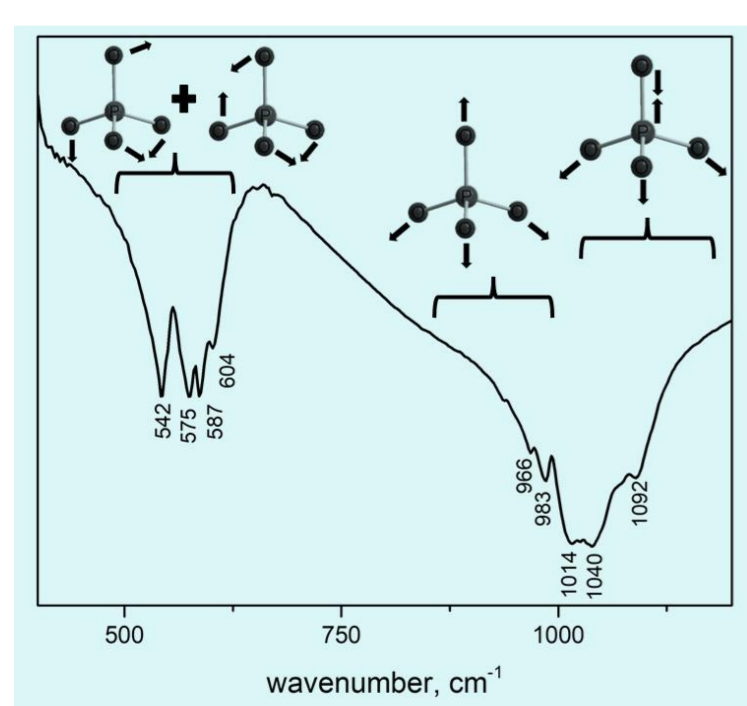


SEM image (a) of the sample's part where EDS maps were taken and EDS mappings for: K (b), Tb (c), P (d), and O (e)

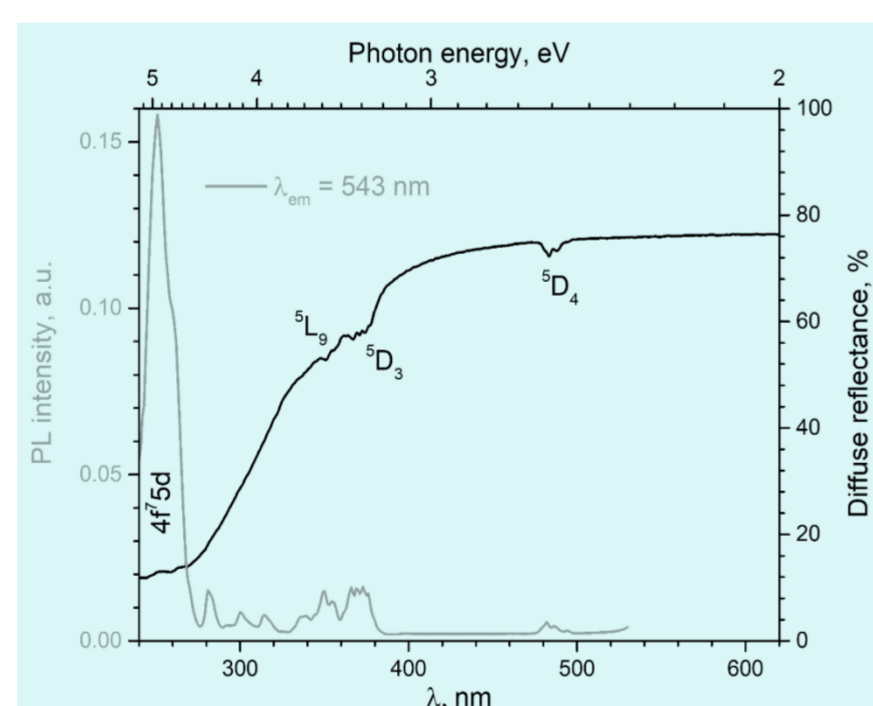
### Crystal structure



## Optical spectroscopy and luminescence features



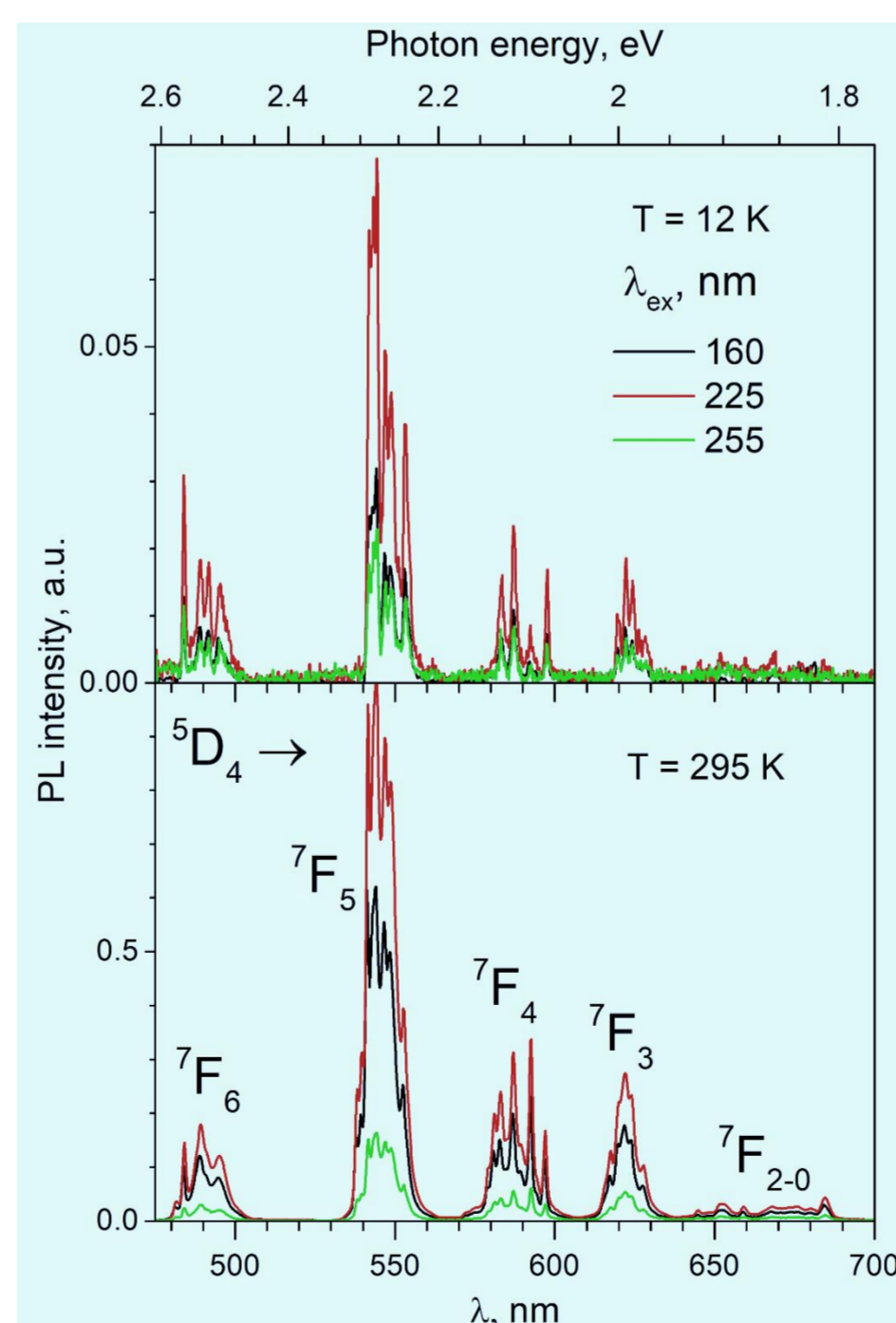
IR spectrum of  $K_3Tb(PO_4)_2$  and assignment of the vibrational modes



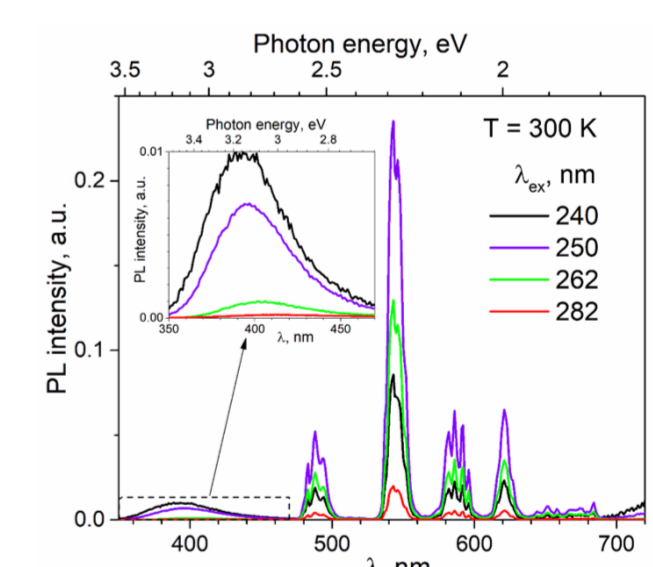
Room temperature the PL excitation (grey) and diffuse reflectance (black) spectra of  $K_3Tb(PO_4)_2$ .

### Quantum yield and color coordinates

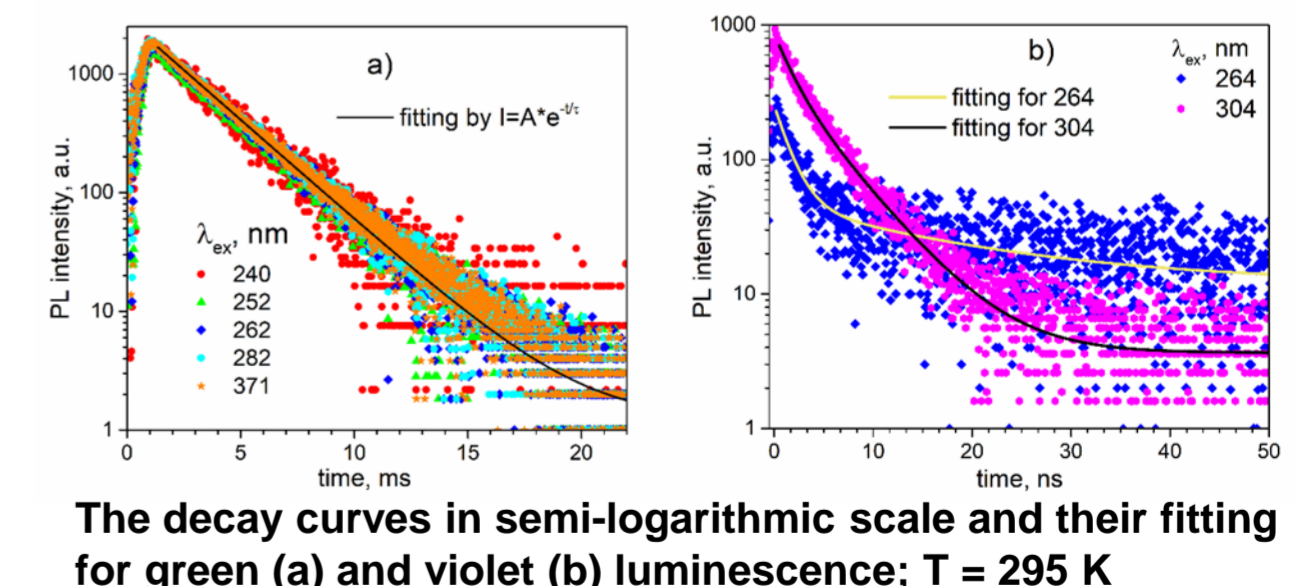
$\lambda_{exc}$ , nm	QY, %	CIE 1931		CIE 1976	
		x	y	u'	v'
262	5.63	0.3613	0.5839	0.1557	0.5660
282	0.68	0.3678	0.5710	0.1614	0.5637
371	1.21	0.3889	0.5650	0.1727	0.5648



The PL spectra at various excitations



PL spectra of  $K_3Tb(PO_4)_2$  under excitations at region of  $O^{2-} \rightarrow Tb^{4+}$  charge transfer band. Inset: enlarged view of the PL bands in 350-470 nm region.



The decay curves in semi-logarithmic scale and their fitting for green (a) and violet (b) luminescence;  $T = 295$  K

## Conclusions

- The  $K_3Tb(PO_4)_2$  reveals layered crystal structure with almost ideal  $PO_4$  tetrahedra and distorted  $TbO_7$  polyhedra.
- The most of experiments were performed on the powders with grains over  $0.5 \mu$  that allow to neglect with surface effects on the optical properties.
- The  $O^{2-} \rightarrow Tb^{4+}$  charge transfer band was observed in diffuse reflectance spectra.
- The PL spectra of the samples consist of narrow lines of the  $f-f$  transitions in  $Tb^{3+}$  ions.
- Despite of the high intensity, the quantum yield of  $K_3Tb(PO_4)_2$  visible luminescence is quite low at used UV excitations.
- The fast violet luminescence of low intensity with maxima near 410 nm was observed at some UV excitations.

## References

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