قياس الأطوال الموجية والزمن الطيفي لمركبـات
فسفورية عالية الإصدار الضوئي

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□ الملخّص □

نظراً للاهتمام الحالي الكبير للمركبات المتفسفرة عالية الإصدار الضوئي في مجال الأطوال الموجية الكبيرة (550-1050nm) ولتطبيقاتها الواسعة في مختلف المجالات الفيزيائية (فيزياء اللايزر –فيزياء أنصاف النواقل– الفيزياء الطبية والتصوير المقطعي الطبقي....الخ).

ونظراً لكون طيف الإصدار الضوئي لهذه المركبات متوافقاً مع حساسية الثنائيات الضوئية من السيليكون، فقد بينا في هذه المقالة مميزات زمن التضاؤل والزمن الطيفي لبعض المركبات المتفسفرة ذات الأطوال الموجية الطويلة مثل:$AL_2O_3:Ti,\ A^PB^{VI}$ وبعض الموليبدات، Y_2O_2S و Gd_2O_2S مع Tb ومواد أخرى. كذلك تم دراسة انتقال سويات الطاقة نحو مراكز التألق وعلاقتها بالانتقالات النسبية.

أجريت القياسات في جامعة بطرس بورغ التكنولوجية الحكومية – بطرس بورغ– روسيا.

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INTRODUCTION

Scintillator applications increase from year to year. One of the best photodetectors for emitting light is a silicon photodiode. In this paper we report our results in search of new phosphors. This search covers long emission wavelengths because applications of silicon photodiodes would benefit from scintillators that emit in the 550-1050 nm wavelength region. We consider the following requirements to studied materials: high light output, short decay time, chemical, mechanical and radiation resistance, and low level of afterglow. Very often we prefer one of the characteristics if it was necessary to solve a concrete task.

EXPERIMENTAL PROCEDURES

The emission spectra have been measured at steady state X-ray excitation (45kV). Two photomultiply tubes (PMT) in different wavelength regions were used. In a short wavelength region it was PMT- 106 (200-680nm) and in a long wavelength region it was PMT- 83 (400-1100nm). In some cases PMT-106 was more preferred than PMT-83, because in wavelength region 400-650 nm PMT -106 is more sensitive. Monochromator MDR-2 was used with both PMTs with gratings 1200splits/mm for PMT-106 and 600 splits/mm for PMT-83. The temperature was varied in 80-500 K range. All the spectra were compared with spectral sensitivity of silicone photodiode. [1] All kinetic measurements have been made using pulsed (less then 1 ns) X-ray source and standard START-STOP detection system. The description of this setup was published by Rodnyi et al. [2] To determine relative light output two methods were used. In both cases standard sample was Csl:Tl to obtain this data in the first method we compared the areas under the spectrum curves of a measured sample and a standard sample. In the second one the number of counts in 50 μs region for a measured sample and a standard one were compared. For level of afterglow measurements we used ultraviolet (UV) excitation (Hg-lamp) and the device for kinetic measurements. To determine the trap properties such as energy levels, their relative concentrations, we used thermo-stimulated luminescence (TSL) method. The TSL measurements were carried out after UV (exposure 2 min) or X-ray (exposure 10 min) excitations. The exposures were carried out at 295 K and glow curves were measured at heating up to 600 k with constant rate (the rate can be varied from 0.5 to 1.0 k/s.) see Fig 1

RESULTS AND DISCUSSION

1- Tikor

monocrystals of $Al_2 O_3$: Ti (tikor) is mainly used as active component for powerful tunable lasers. And now tikor attracts attention as scintillation material [3]. The samples were grown by method of horizontal oriented crystallization in vacuum and argon-carbon atmosphere with velocity 1.5-6 mm/h. the proportion of absorption coefficients in wavelength region 490 nm and 800nm, which characterizes Ti^{3+} /Ti^{4+} proportion, was equal 200 for AL_2O_3: Ti (0.07mass %) sample. At room temperature we observe three main wide bands: long –wavelength band at 705 nm with 0.31 eV halfwidth, short wavelength band at 315 nm with 0.8 eV halfwidth, and not intensive one at 420 nm. The intensive long –wavelength luminescence with decay time constant 3.4 $\pm$ 0.1 μs associated withTi^{3+} transmission $^2E \circledR \ ^2T_2$ in AL_2O_3 [4,5]. The intensity of 705 nm band

increases (about 50%) with the temperature decreasing to 80 k. the relative intensity of this band is equal to 14% of standard scintillator Csl : Tl at room temperature. The short wavelength band shows two decay time constants: $t_1 = 0.13 \pm 0.01$ ms and $t_2 = 1.3 \pm 0.1$. ms. Its intensity is growing more than three times with temperature decreasing. The band at 420 nm is usually associated with charge transfer emission [5,6]. In this case Ti^{4+} traps an electron and becomes Ti^{3+} with a quantum emission. In introduction we paid attention to possibility of using long-wavelength scintillator with silicon photodiodes as a photodetector. Fig 2 presents the silicon photodiodes sensitivity [1] compared to the tikor spectrum.

2- Y and Gd oxysulphides doped with Tb

Yttrium and gadolinium oxysulphides doped with rare earth elements are widely used as efficient cathode-and X-ray phosphors [7,8]. We studied ceramic Y_2O_2S: Tb and Gd_2O_2S:Tb samples. The spectra of this samples contained only lines associated with radiative transitions in the activators. We observed $^5D_3$-^7F_j and $^5D_4$-^7F_j (J= 1-6) transitions in the emission spectra (see Fig 3) This figure shows the transition lines spectrum at definite wave length for the Tb doped in the Ceramic. compound we have studied The kinetic measurements show decay time constants in range of 150-250 ms. In this investigation we are primarily interested in the light yield output of this samples in comparison with Csl:Tl. We were interested in light yield output for photons which had the same direction with incident X-ray and for photons which were emitted at the sample side opposite to incident X-ray. The other point of our interest was such characteristic as afterglow. We separated the samples with smallest level of afterglow and highest light output. Thus technological conditions of the ceramic preparations have determined. For more clear understanding of technological condition influence on luminescence properties of the samples the TSL measurements have been also fulfilled.

3- Molybdates

Different tungstates are known as good scintillators with high density, while a little known about scintillation properties of Molybdates. Very often Molybdates are followed with tungstates. Apart from the WO_3^{2-} - group the Mo impurity (i.e. the $(MoO_4)^{2-}$ group) was ascribed to the emission component around 520 nm[9]. We studied some molybdate crystals such as $CaMoO_4$, $SrMoO_4$, NaLa $(MoO_4)_2$. The crystals exhibit broad (~ 0.7 eV) emission bands peaked at 537 nm ($CaMoO_4$), 513 nm ($SrMoO_4$), 540 nm and 605 nm (LaNa $(MoO_4)_2$). Kinetic measurements show that these scintillation materials have two exponential components, one of which is fast. We obtained the following data of decay time constant for this scintillators (fast/slow components): 90 ns /5.0 ms, 4.2 ns /0.9 ms and 4.2 ns/1.2 ms for $CaMoO_4$, $SrMoO_4$ and $NaLa(MoO_4)_2$, respectively. The $SrMoO_4$ exhibits largest light output among the crystals. A little is known about luminescence centres in molybdates. We can suppose that the nature of luminescence is self-trapped exitons (STE) and that the fast and slow emission components are related to singlet and triplet STE's correspondingly.

4- A^2B^6:

A^2B^6 compounds are coming into use as effective phosphors. But there are some problems to grow single crystal phosphor on base of ZnS. We studied scintillation properties of transparent homogeneous polycrystalline samples of Zns and ZnS-ZnSe solid solutions doped by Ag and Cu. We investigated spectral characteristics, which

varied from sample to sample depending on growing conditions. For example ZnS: Cu samples show from one (534 nm) to three (456, 518, 608 nm) peaks depending on condensation temperature and barium concentration in flax. In ZnS-ZnSe solid solution there is no so high dependence but we observed a high difference in luminescence intensity for this samples. At this moment we can't explain the kinetic properties of luminescence centres of this samples because many influences on it (temperature conditions of the samples preparation, type of flux and its concentration, concentration of activators and so- activators, correlation between wurzite and sphalerite phase in the samples). We can only say that the shortest decay was 13 ns in a sample of this set of compounds. All resuls are summerized in table 1.

Table1:Spectral and kinetic properties of some long-wavelength phosphors.

Sample	l_{m}, nm	t, ns
Al_2O_3 : Ti	315	130
	420	1300
	705	3400
Gd_2O_2S: Tb	370-730	$1.5\text{-}2.5.10^5$
$CaMoO_4$	537	90,5000
$SrMoO_4$	513	4.2,900
$LaNa(MaO_4)_2$	540,605	4.2,1200
ZnS-ZnSe(50%50%): Cu,Al	580	13
$Na(Nd)\,MgAl\,(Cr)_{11}O_{19}$	694,709,750	453
CdI_2	532,564	2.4
$BaSO_4$:Pr	480,600,637	9

CONCLUSIONS

The findings show that the characteristics of some studied scitillators can be improved. Therefore, we have to choose optimal growth conditions, concentration of activator and co-activator, and type of flux. Besides, we plan to vary the post-growth conditions, particularly the cooling rate

ACKNOWLEDGEMENTS:
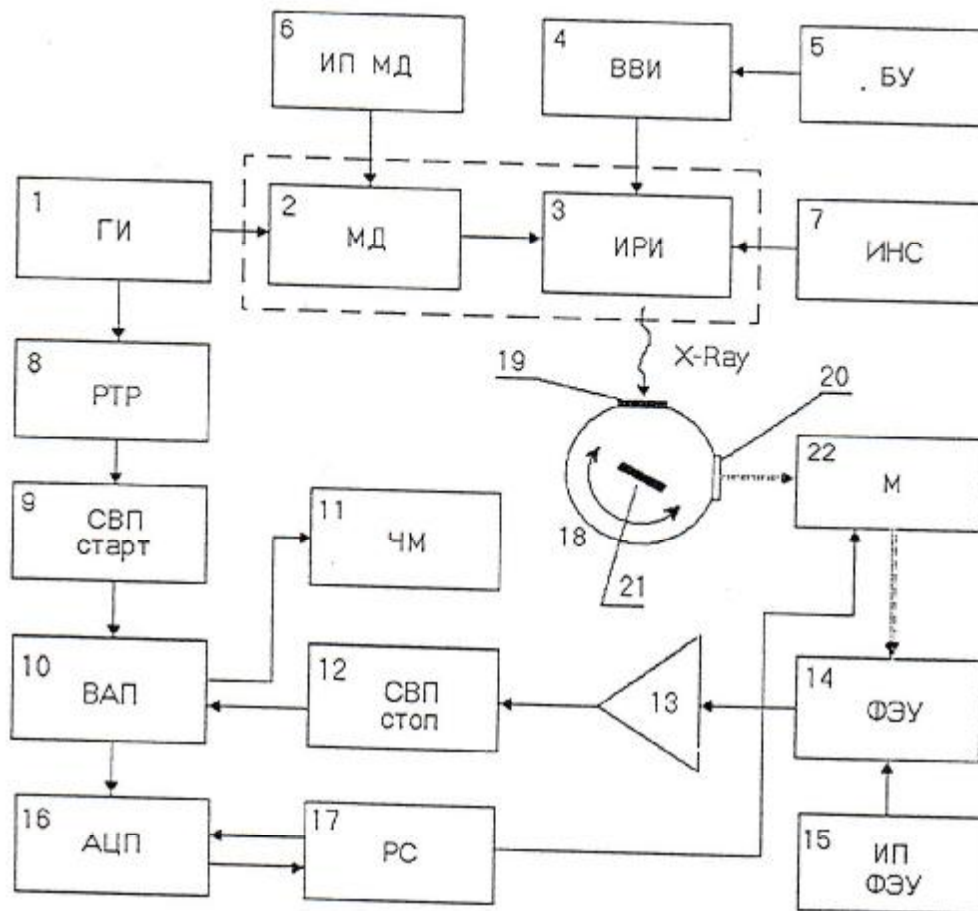
Fig 1: shows the instruments used in measuring the RL (X-Ray luminescence), TSL (Thermoluminescence)

1-Variable frequency generator.

2- Rheostat.

3- X-Ray pulses generator.

4- High power supply.

5- Control unit.

6- Modulating power supply.

7-Variable power supply.

8-Cut universal.

9-Time control connected to channel CTRAT.

10-Variable time modulator.

11- Frequency measuring.

12- Time control connected to channel CTOP.

13- Amplifier.

14-Optical electron generator.

15-Power supply for optical electron generator.

16- Variable digital analyzers.

17- IBM PC computer.

18-Cryostat.

19-Windows for cryostat Of Beryllium.

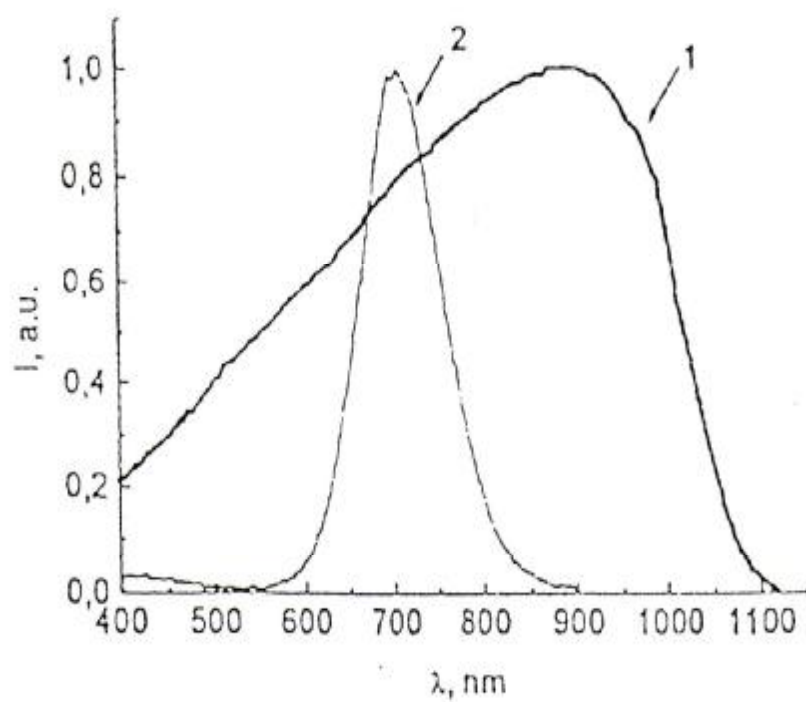20-Quarts windows.

21- Sample.

22- Analyzer.

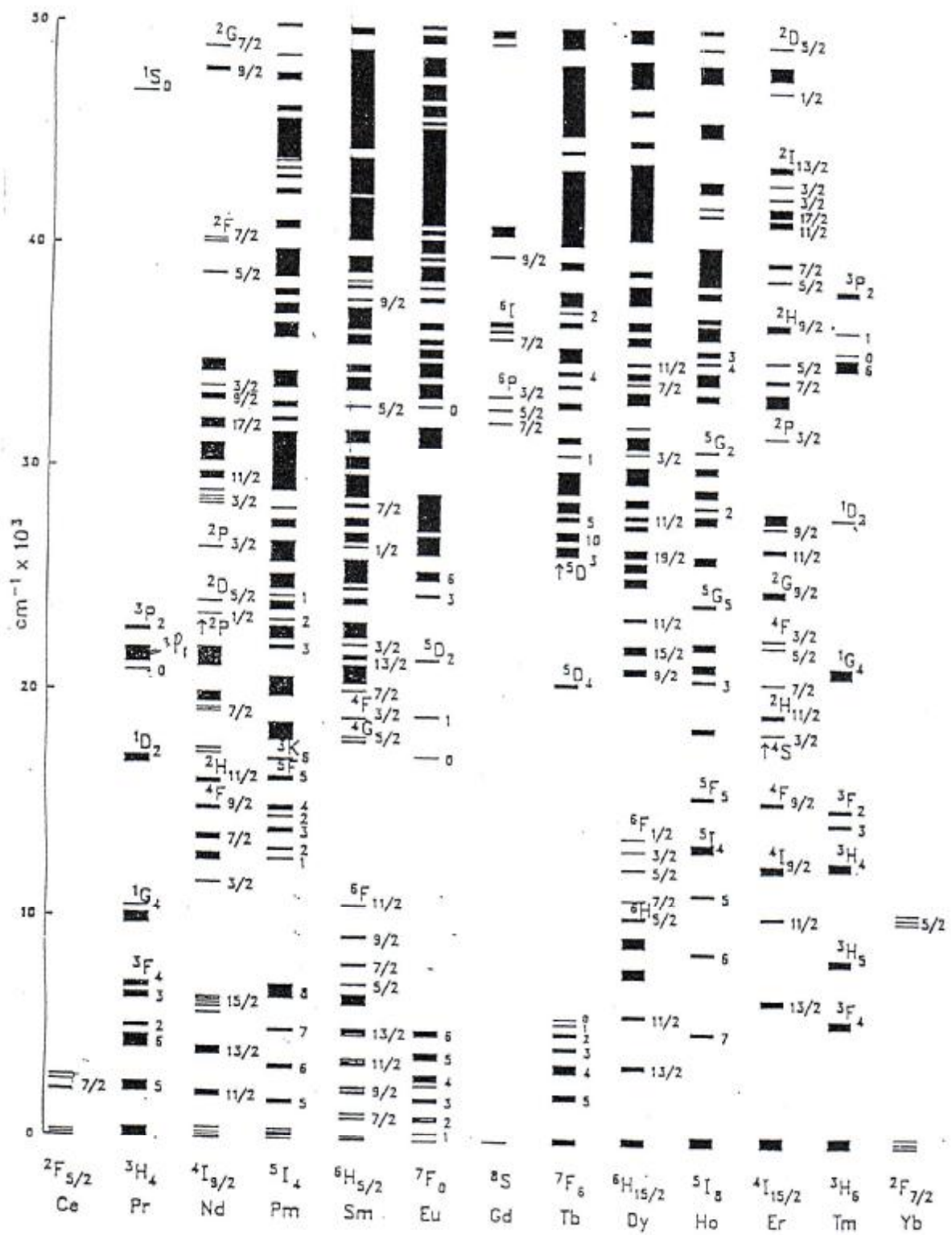Fig 2. Normalized silicon photodiodes sensitivity (1) and tikor emission spectrum (2)

Fig 3. ENERGY LEVELS OF THE +3 LANTHANIDES IN LaF$_3$

REFERENCES:

••••••••••••••••••••••••••••••

1- C.D. Greskovich et al., "Ceramic Scintillators For Advanced, Medical X-Ray Detectors", American Ceramic Society Bulletin, 71(7), 1120-1129, (1992).

2- P.A. Rodnyi et al., " A Source Of X-Ray Pulses", instr. And Exp. Tech. 43(5),698-700, (2000)

3- V.Ryzhikov, L Nagornaya, V. Chernikov et al, LUMDETR '2000,book of abstracts, Riga, p.57,(2000)

4- Yamada, T. Yosida, S. Hara et al. Appl. Phys. 75(2), 1111-1117, (1994).

5- W.C. Wong, D.S. McClure, S.A. Basun at al. Phys. Rev. 51(9), 5682-5689(1995).

6- E. Ruza. Et al. J. Phys: Condens Matter 10, 4297-4306 (1998)

7- H. Yamada et al. "A Scintillator $Gd_2 O_2S$:Pr, Ce, F for X- ray computed tomograpgy", J Electrochem. Soc. 136(9) 2713-2721(1989)

8- W.Rossner et al. "The Conversion Of High Energy Radiation To Visible Light By Luminescence Ceramics," IEEE Trans. On Nuclear Science, 40,376-379(1993)

9- M. Nikl, "Wide Band Gap Scintillation Material Progress In The Technology And Material Understanding, ", phys. Stat. Sol 178, 595-619 (2000)

The Octupole Correlations In The ^{209}bi,^{209}pb Nuclei

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◻ **ABSTRACT** ◻

The self consistent Hartree-Fock-Bogoliubov problem for nuclei with A=209 is solved by using the variation principle. Accordingly, the octupole coupling of $h_{\frac{9}{2}}$ ⊗ $d_{\frac{3}{2}}$ and $i_{\frac{13}{2}}$ ⊗ $h_{\frac{9}{2}}$ of the nucleus ^{209}Bi have been calculated for different octupole strengths. Moreover, the octupole coupling between $j_{\frac{15}{2}}$ ⊗ $g_{\frac{9}{2}}$ of the nucleus ^{209}Pb has been also calculated.

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ارتبـاطات ثمـاني القطب فـي النـواتيـن ^{209}Pb, ^{209}Bi

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□ الملخّص □

حلت مسألة هارتري-فوك-بوغليوبوف للأنوية التي لها عدد كتلي   A=209   باستخدام مبدأ التغير. وتم حساب ارتباط ثماني قطب للإنتقالين $d_{\frac{3}{2}}$ ⊗ $h_{\frac{9}{2}}$ ، $h_{\frac{9}{2}}$ ⊗ $i_{\frac{13}{2}}$ للنواة ^{209}Bi من أجل سعات مختلفة لاهتزاز ثماني القطب. وأخيراً حسبنا ارتباط ثماني قطب للإنتقال $g_{\frac{9}{2}}$ ⊗ $j_{\frac{15}{2}}$ للنواة ^{209}Pb.

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