Supplementary Data

Details of graphical fitting of data for all samples

In this paper we present the analysis of thermoluminescence kinetic features of strontium pyrophosphates after beta irradiation. TL glow curves were recorded from the phosphor for different beta doses. The experimental TL glow curves are denoted in the main paper. In this paper several methods are adopted to analyze the TL glow by considering theoretical assumptions. In the supplementary data, the graphs give the physical significance of the experimental data analyzed by different methods for all samples.

Figure 1 shows the graph of TL intensity (I)→ Temperature (T) graph to determine the glow curve parameters using the peak shape method. The glow curve parameters for the sample irradiated by 50Gy β-radiation.

Figure 2 shows the graphs of ln[TL/(Area)b]→1/kT of $Sr_2P_2O_7$ doped with different concentration of Eu^{3+} analyzed by whole curve method fitted by linear regression for different values of 'b' and figure 2[1] shows the graph of Residue {ln[TL/(Area)b]}→1/kT graphs of Eu^{3+} doped $Sr_2P_2O_7$ analyzed by whole curve method fitted by linear regression for different values of 'b'. The consistent results are obtained for different doses and concentrations of doping. The linear fitting of experimental data is been evaluated for precise regression coefficient. The calculate parameters like activation energy and order of kinetics by whole curve method is illustrated in Table 1. The best linear fitting data of all samples mentioned in Table 1 of supplementary data which is presented in Table 1 of main manuscript.

Figure 3 shows the graphs of [ln(I)]→1/kT of $Sr_2P_2O_7$ doped with different concentration of Eu^{3+} for initial rise method fitted by linear regression and figure 3[1] Residue [ln(I)]→1/kT graphs of Eu^{3+} doped $Se_2P_2O_7$ for IR method fitted by linear regression. The significant regression linear fitting data is been obtained and the activation energy calculated from the slop of the graph. Obtained values of activation energy is been mentioned in main manuscript.

Figure 4 shows the graphs of TL intensity (I)→Temperature (T) for Kitis et al. equation of second-order of activation energy analysis for samples (a) $Sr_2P_2O_7$: 0.1% Eu; (b) $Sr_2P_2O_7$: 0.5% Eu; (c) $Sr_2P_2O_7$: 1.0% Eu; (d) $Sr_2P_2O_7$: 1.5% Eu (e) $Sr_2P_2O_7$: 2.0% Eu (f) $Sr_2P_2O_7$: 2.5% Eu (g) $Sr_2P_2O_7$: 5.0% Eu. Experimental glow curves of all samples are fitted with the theoretical glow curves determined by Kitis et al. second-order equation. It is also called as GCD (glow curve deconvolution) fitting of TL glow curve. The glow curves are fitted for the different activation energy in which perfect curve give the lowest FOM (figure of merit). Low FOM represent that the experimental and theoretical curves are overlapped on each other. Figure 5 shows the graphs of Figure of merit (FOM)→Activation energy (E_a) of Eu^{3+} doped $Sr_2P_2O_7$ analyzed by Kitis et al. equation of second-order kinetics. The precise value of activation energy of each phosphor was considered from the fitted curves. The detail summary of activation energy and FOM is given in Table 2. Significant value of activation energy of all samples were mentioned in Table 2 of supplementary data is been represented in Table 3 of main manuscript. In this paper, theoretical and experimental comparison gives the importance of TL properties of the phosphor for its TL applications.

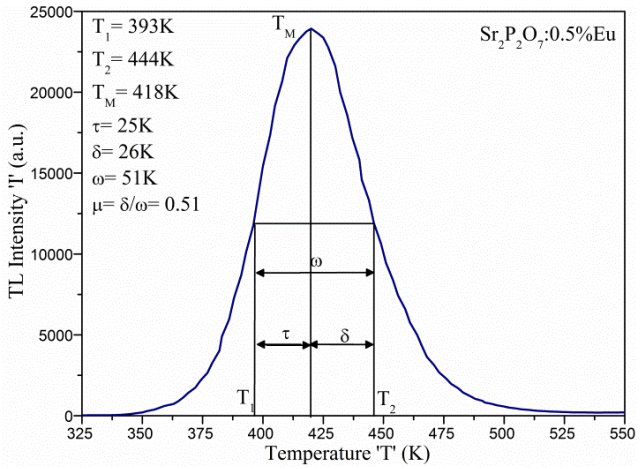

Figure 1. TL intensity (I)→Temperature (T) graphs of 0.5%Eu^{3+} doped $Sr_2P_2O_7$ exposed with 50Gy β-irradiation to analyzed glow curve by peak shape method.

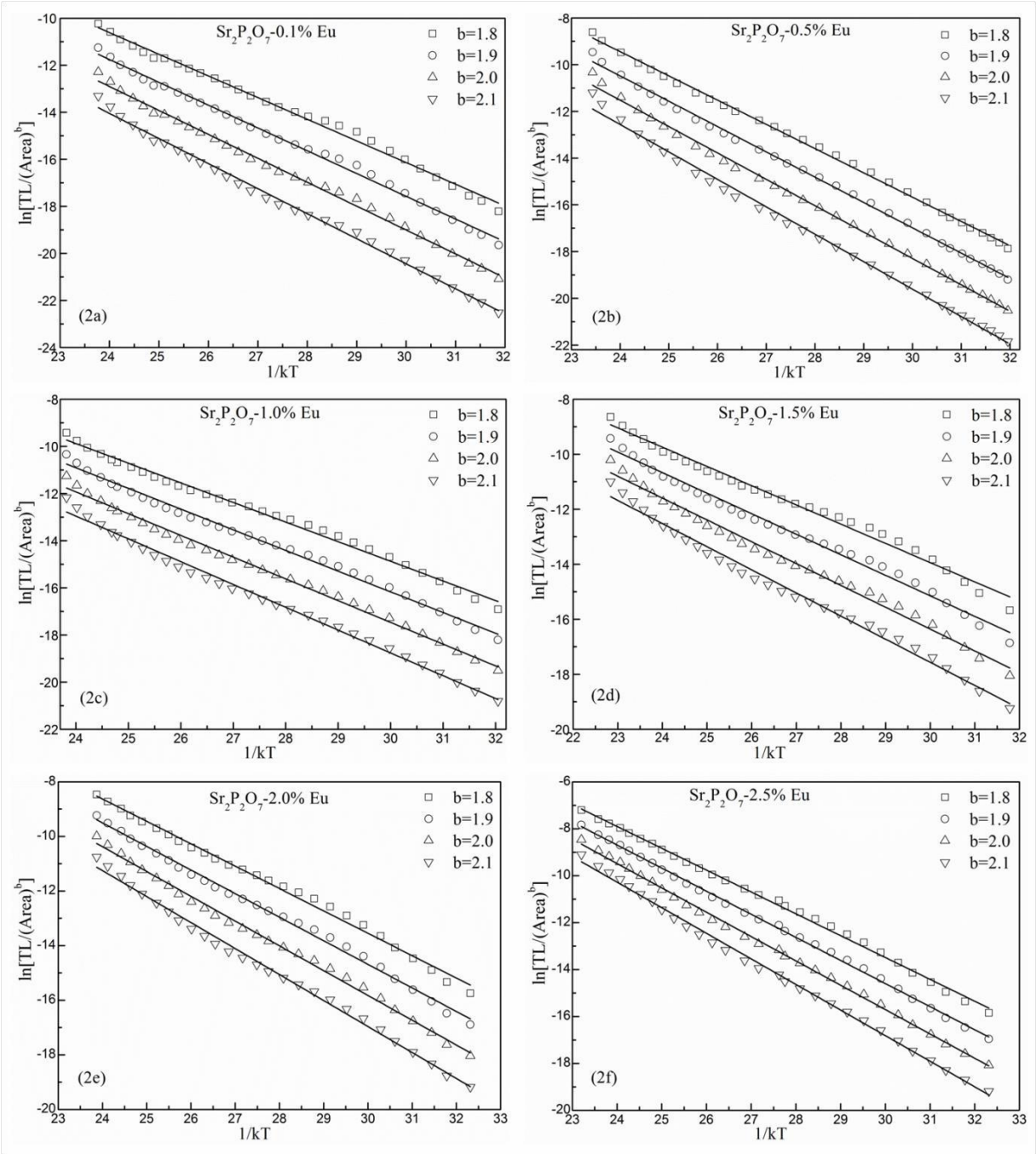

Figure 2. ln[TL/(Area)b]→1/kT graphs of Eu^{3+} doped $Sr_2P_2O_7$ analyzed by whole curve method fittedby linear regression for different values of 'b'.

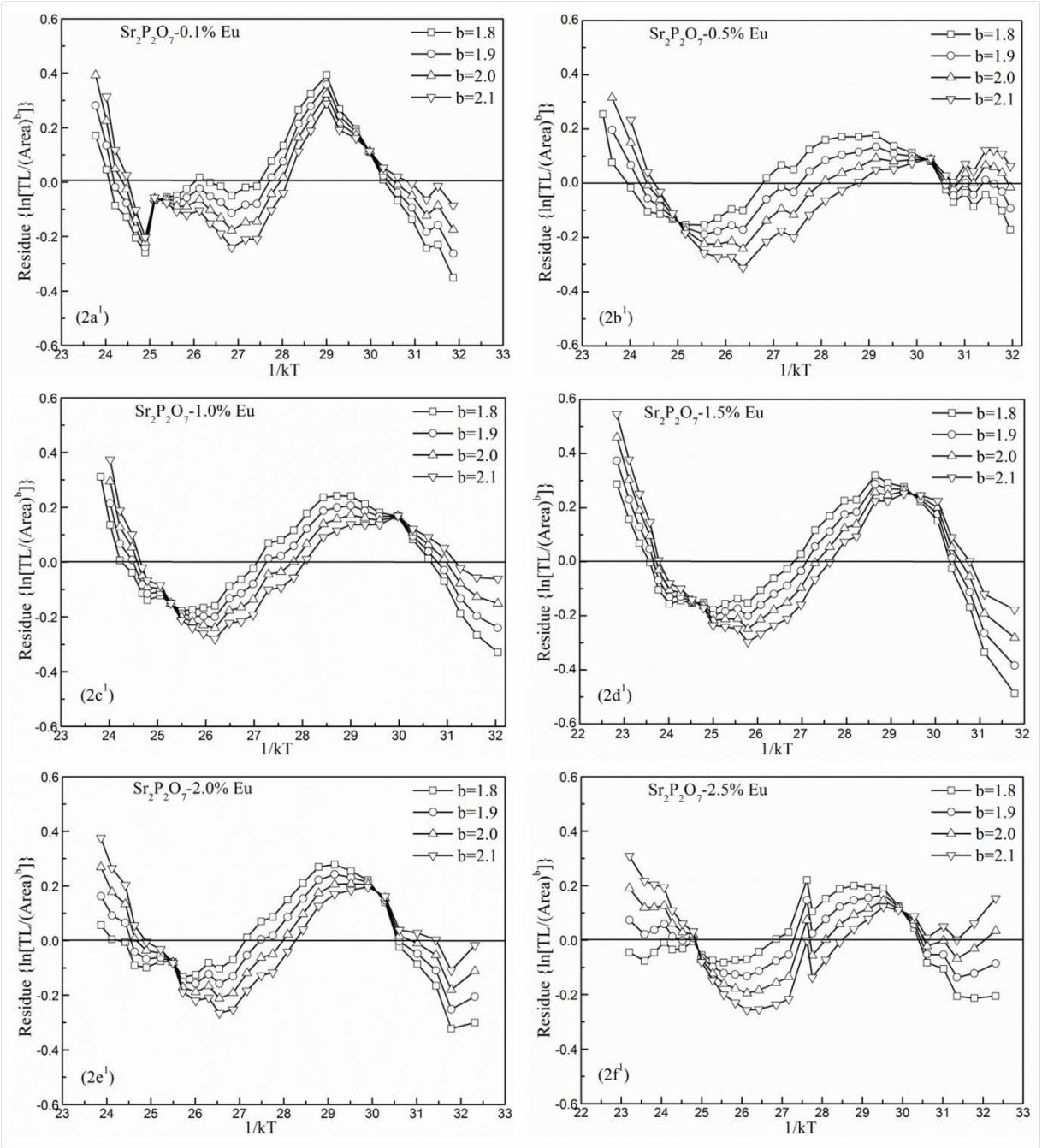

Figure 2[1]. Residue {ln[TL/(Area)b]}→1/kT graphs of Eu^{3+} doped $Sr_2P_2O_7$ analyzed by whole curve method fitted by linear regression for different values of 'b'.

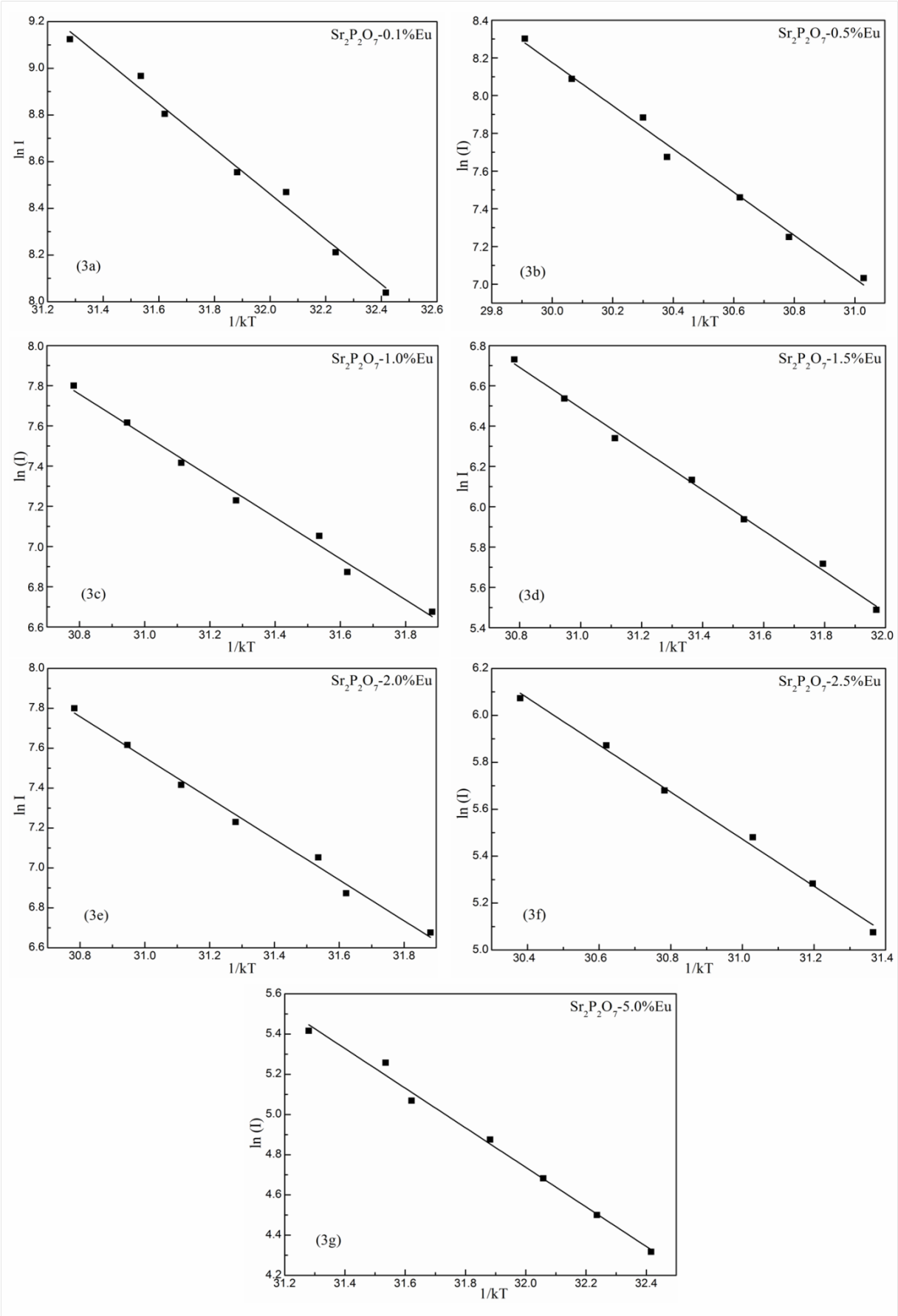

Figure 3. [ln(I)]→1/kT graphs of Eu^{3+} doped $Sr_2P_2O_7$ for IR method fitted by linear regression.

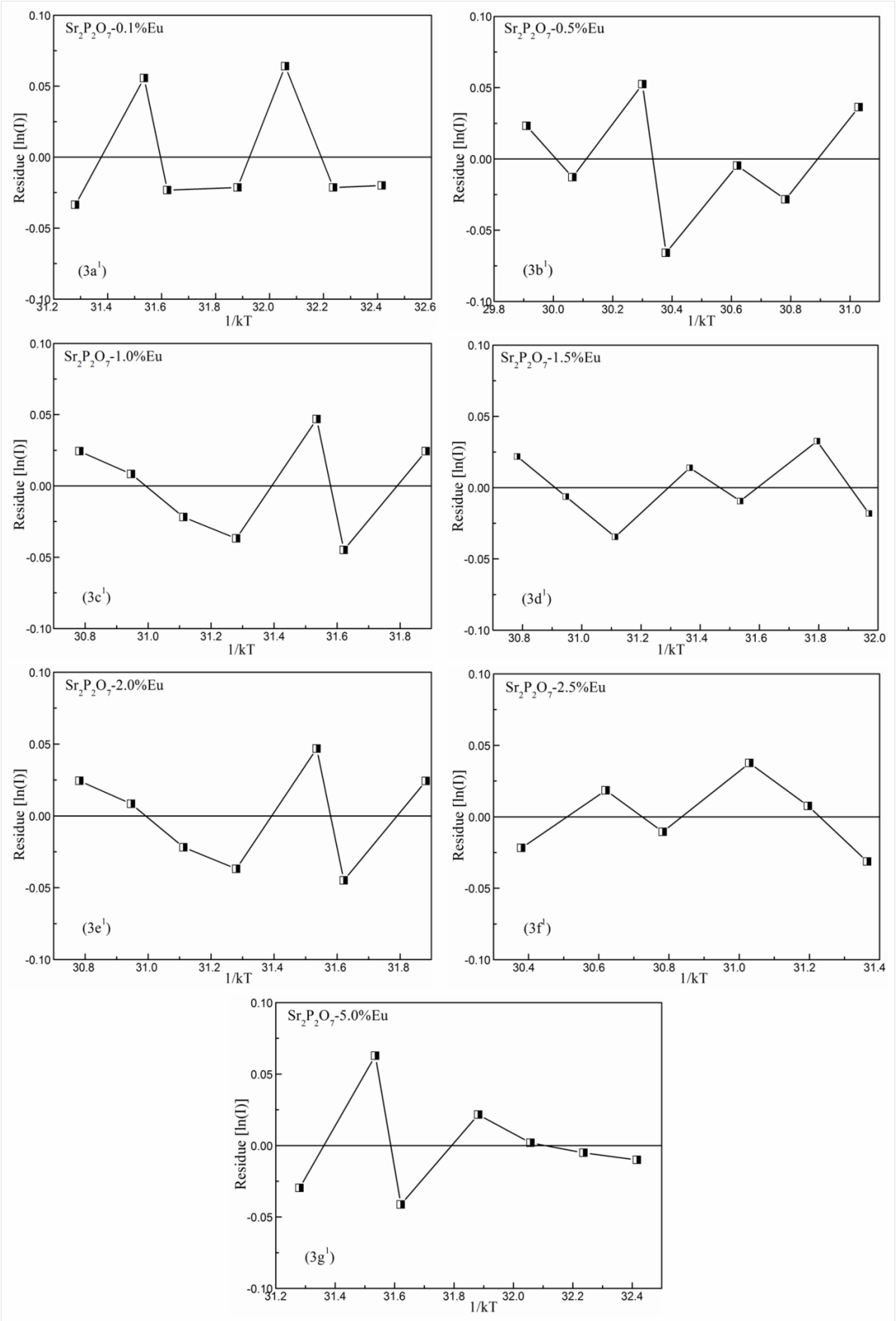

Figure 3[1]. Residue [ln(I)]→1/kT graphs of Eu^{3+} doped $Se_2P_2O_7$ for IR method fitted by linear regression.

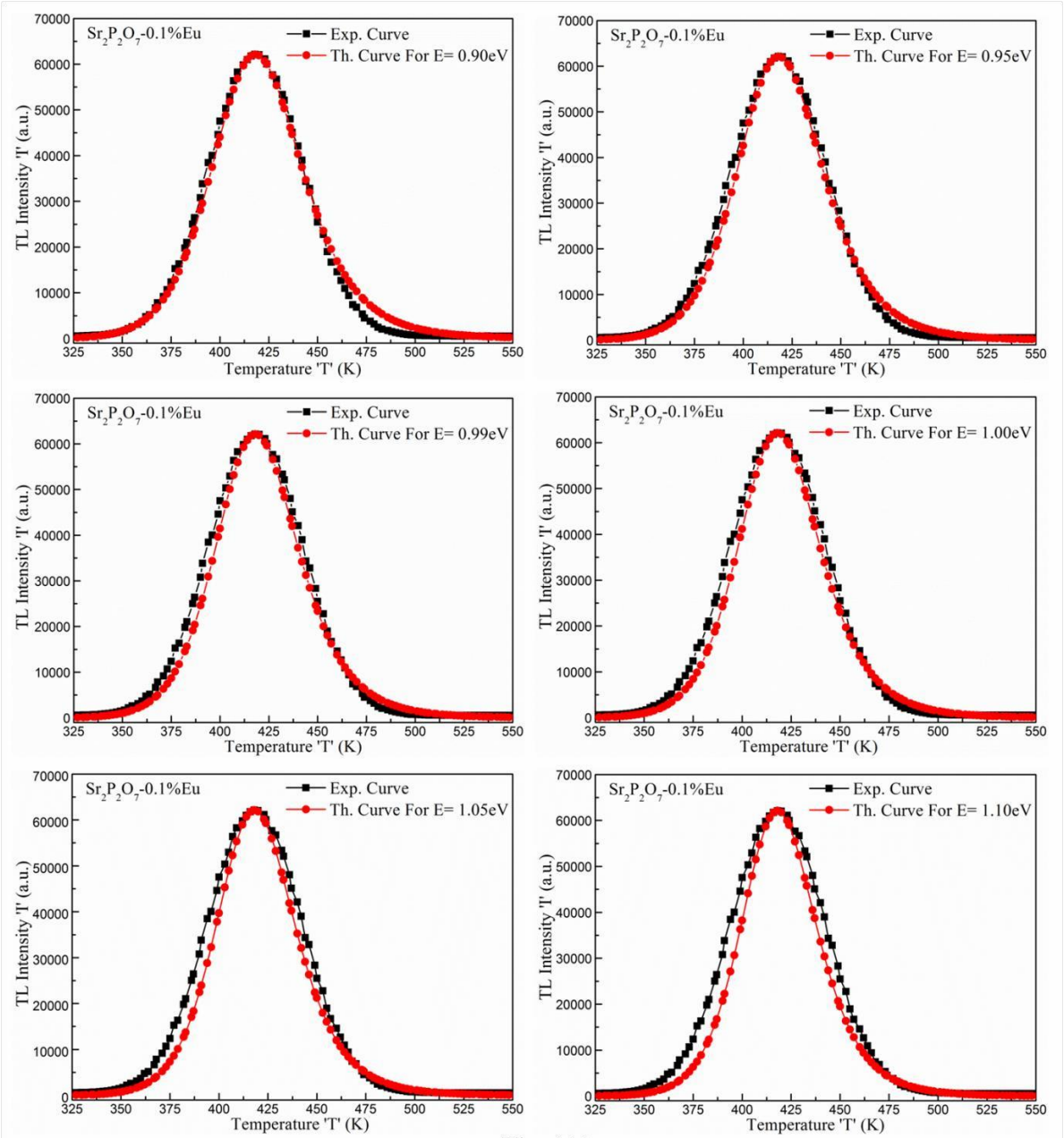
Sr2P2O7-0.1%Eu
Exp. Curve
Th. Curve For E= 0.90eV
Th. Curve For E= 0.95eV
Th. Curve For E= 0.99eV
Th. Curve For E= 1.00eV
Th. Curve For E= 1.05eV
Th. Curve For E= 1.10eV
TL Intensity 'I' (a.u.)
Temperature 'T' (K)

Fig. 4(a)

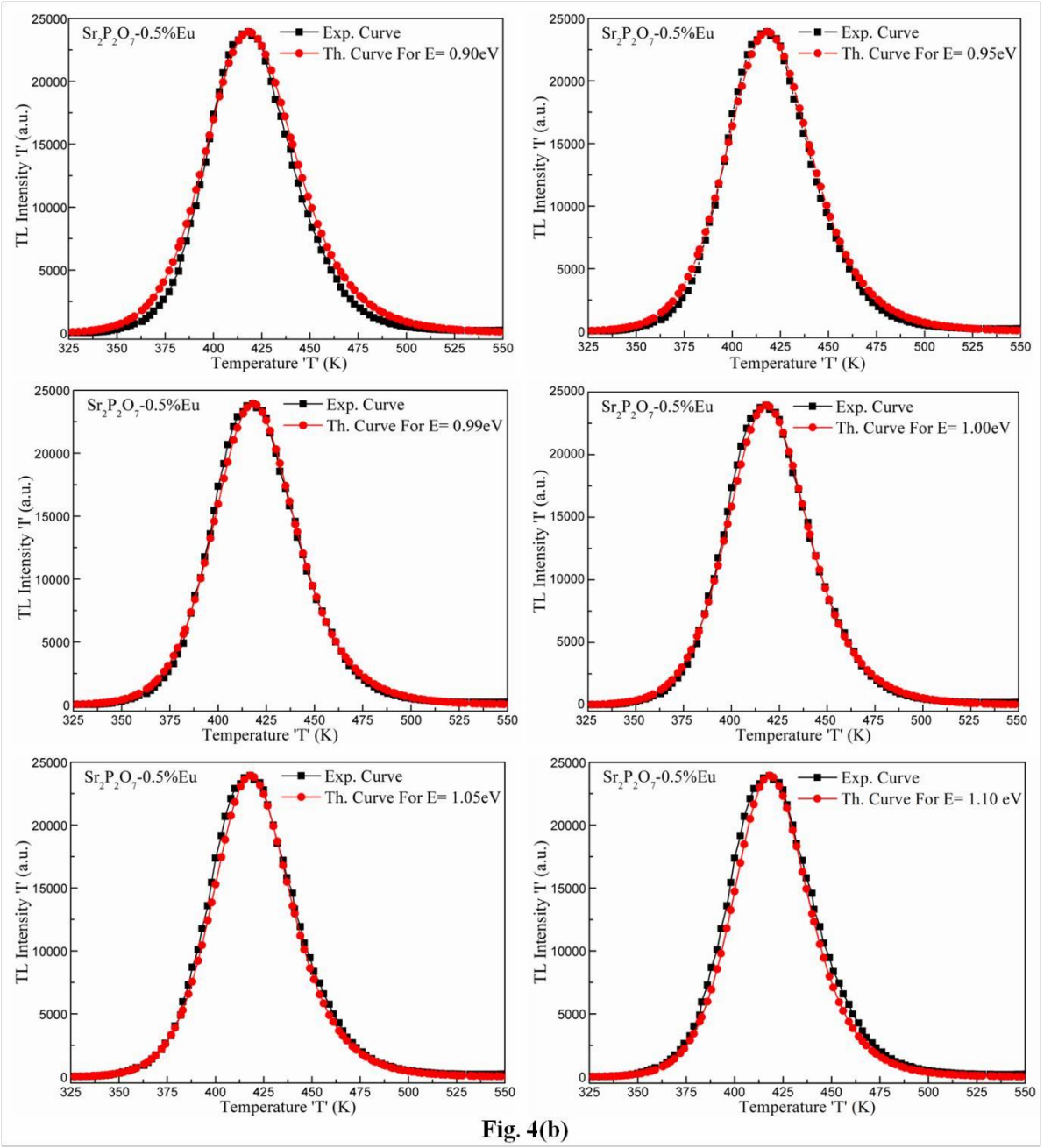
Sr2P2O7-0.5%Eu
Exp. Curve
Th. Curve For E= 0.90eV
Th. Curve For E= 0.95eV
Th. Curve For E= 0.99eV
Th. Curve For E= 1.00eV
Th. Curve For E= 1.05eV
Th. Curve For E= 1.10 eV
TL Intensity 'I' (a.u.)
Temperature 'T' (K)

Fig. 4(b)

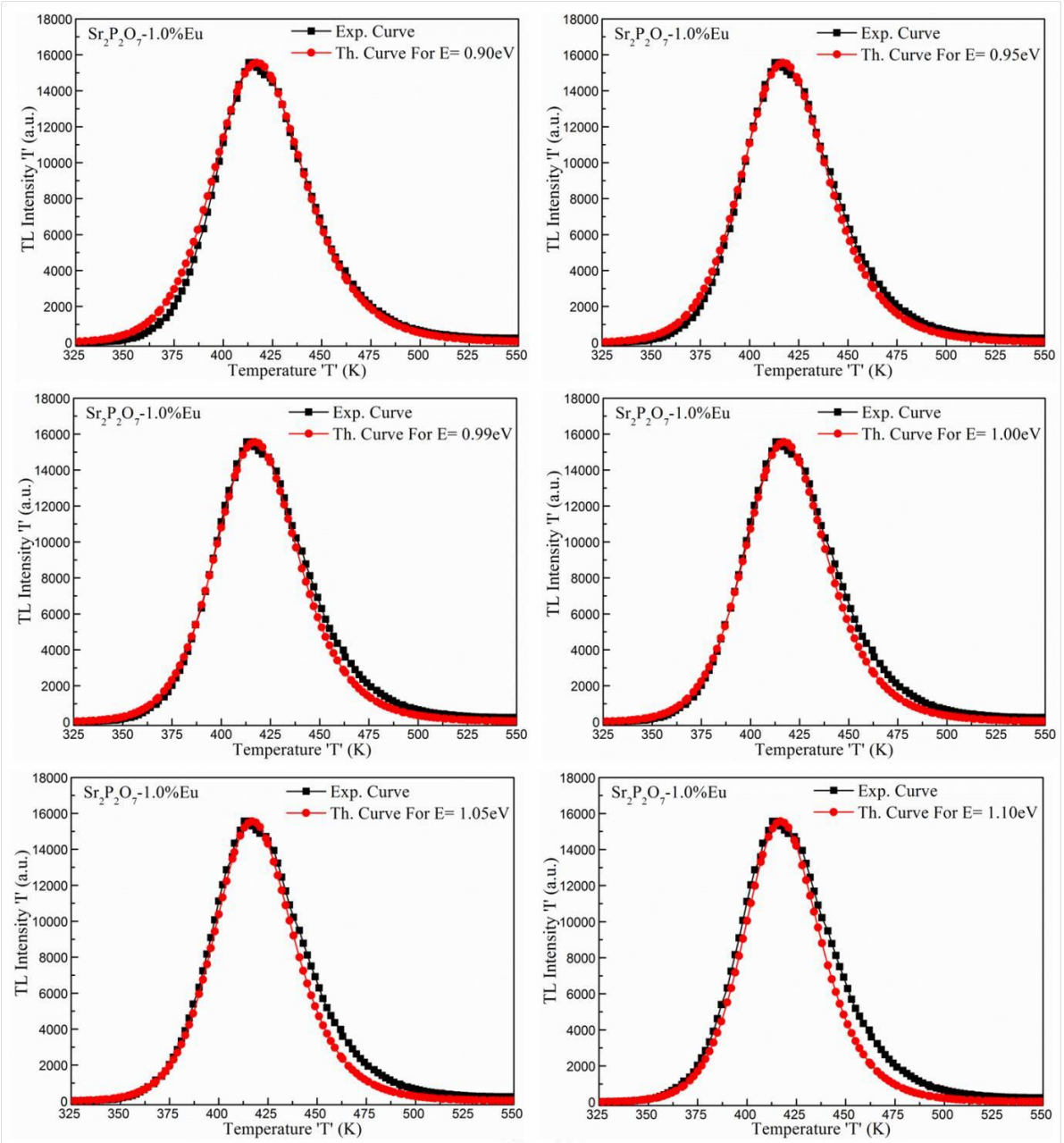
Sr2P2O7-1.0%Eu
Exp. Curve
Th. Curve For E= 0.90eV
Th. Curve For E= 0.95eV
Th. Curve For E= 0.99eV
Th. Curve For E= 1.00eV
Th. Curve For E= 1.05eV
Th. Curve For E= 1.10eV
TL Intensity 'I' (a.u.)
Temperature 'T' (K)

Fig. 4(c)

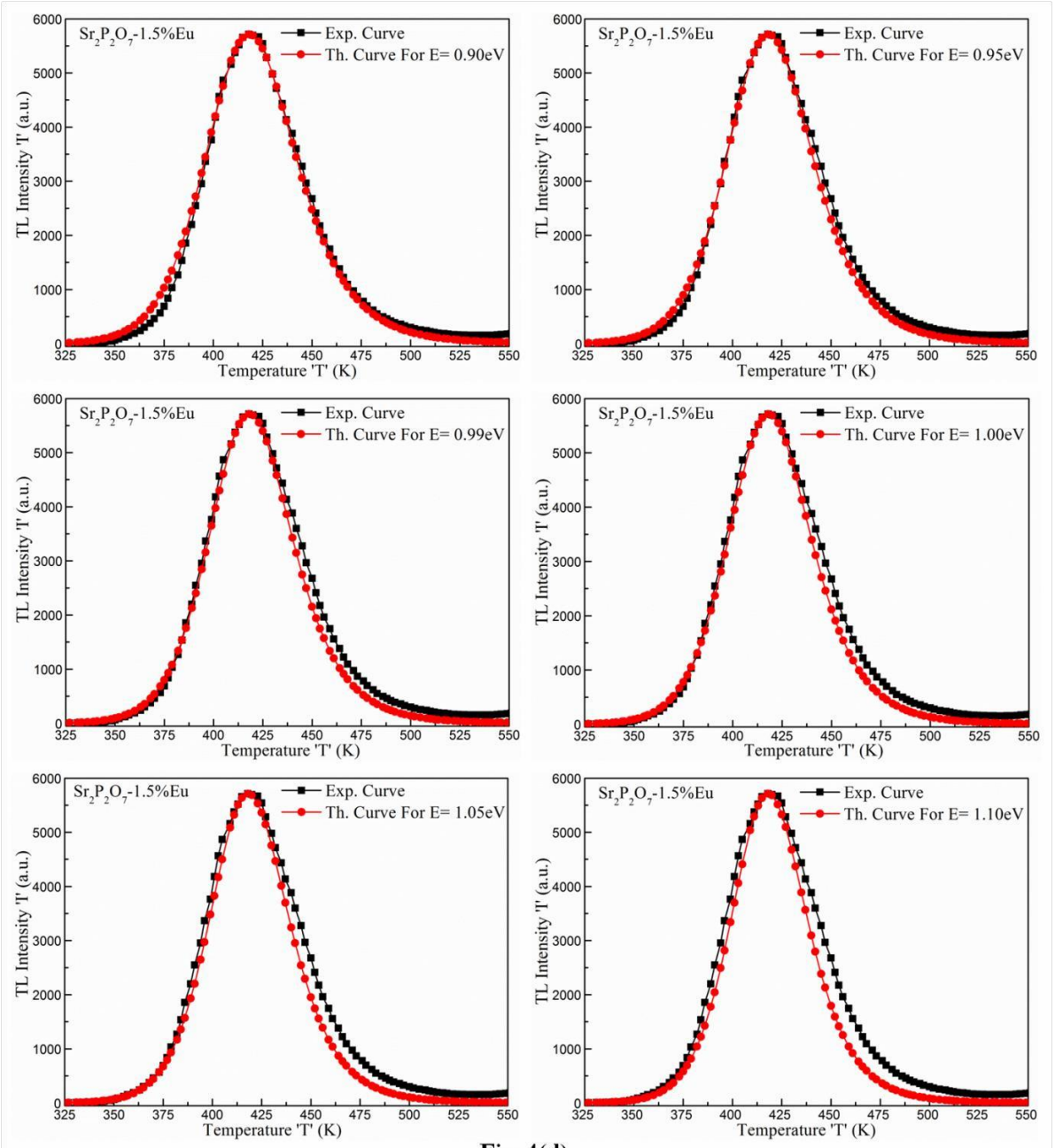
Sr2P2O7-1.5%Eu
Exp. Curve
Th. Curve For E= 0.90eV
Th. Curve For E= 0.95eV
Th. Curve For E= 0.99eV
Th. Curve For E= 1.00eV
Th. Curve For E= 1.05eV
Th. Curve For E= 1.10eV
TL Intensity 'I' (a.u.)
Temperature 'T' (K)

Fig. 4(d)

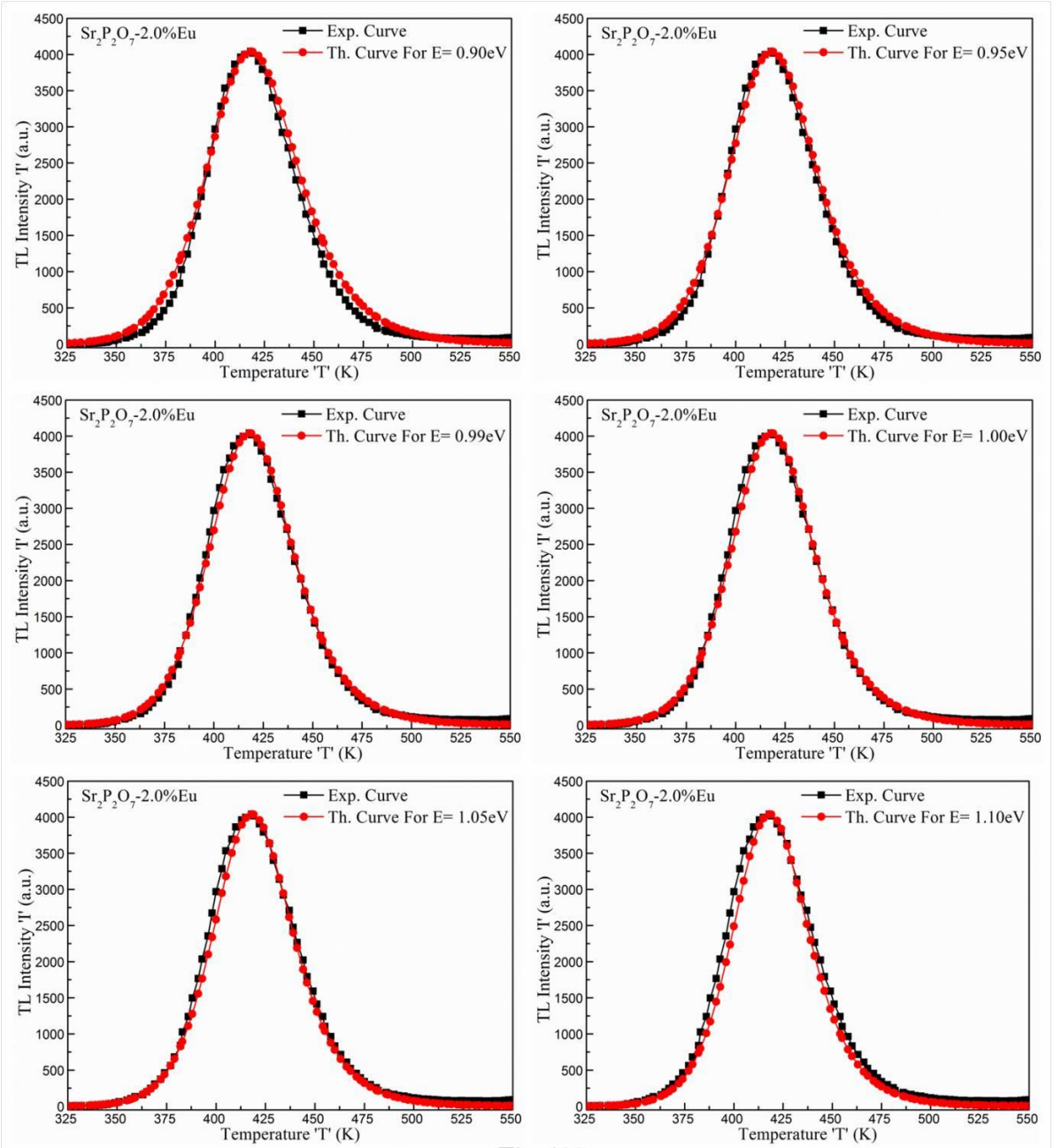
Sr2P2O7-2.0%Eu
Exp. Curve
Th. Curve For E= 0.90eV
Th. Curve For E= 0.95eV
Th. Curve For E= 0.99eV
Th. Curve For E= 1.00eV
Th. Curve For E= 1.05eV
Th. Curve For E= 1.10eV
TL Intensity 'I' (a.u.)
Temperature 'T' (K)

Fig. 4(e)

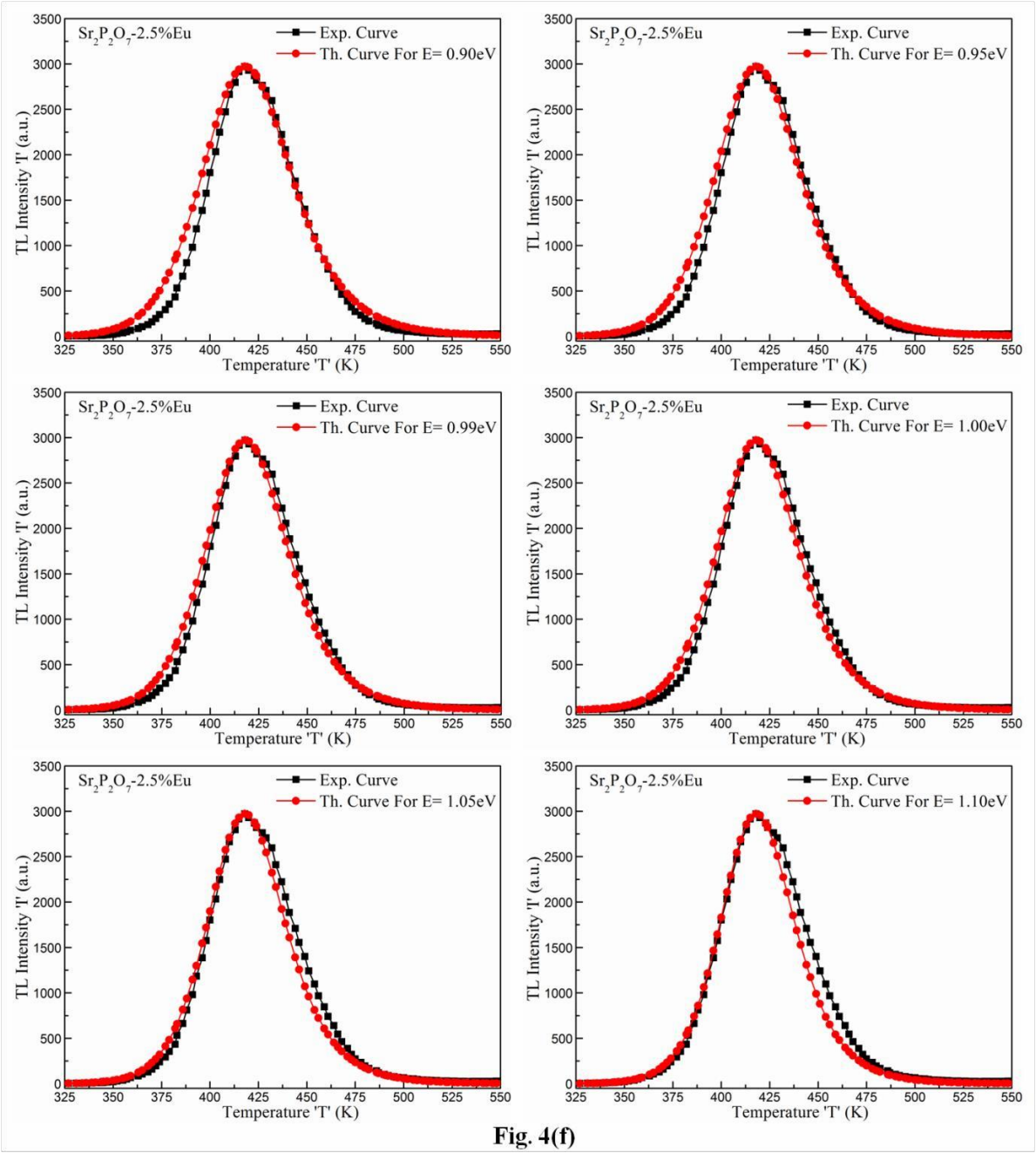
Sr2P2O7-2.5%Eu
Exp. Curve
Th. Curve For E= 0.90eV
Th. Curve For E= 0.95eV
Th. Curve For E= 0.99eV
Th. Curve For E= 1.00eV
Th. Curve For E= 1.05eV
Th. Curve For E= 1.10eV
TL Intensity 'I' (a.u.)
Temperature 'T' (K)

Fig. 4(f)

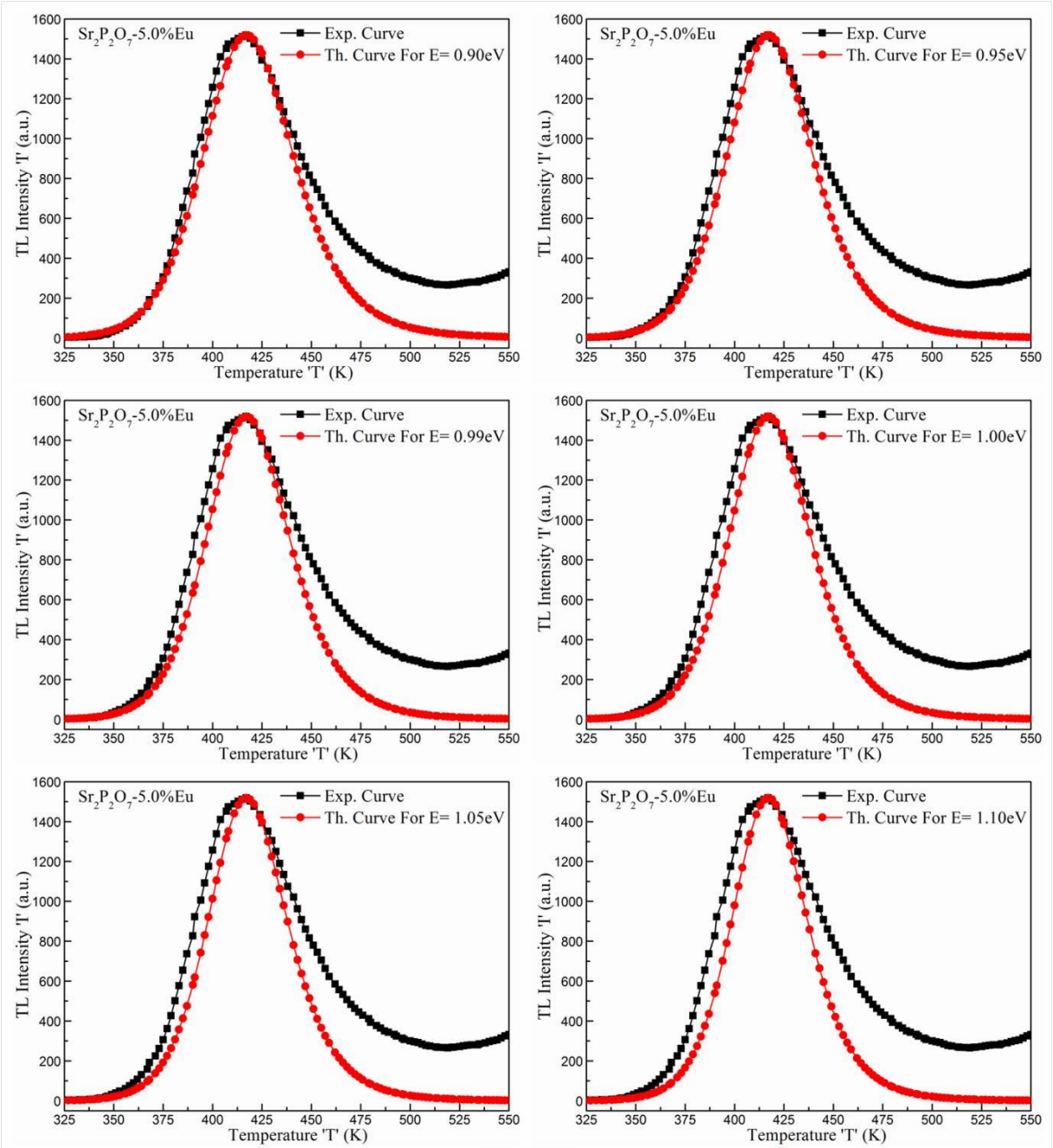

Figure 4. TL intensity (I)→Temperature (T) graphs for Kitis et al. equation of second-order of activation energy analysis. (a) $Sr_2P_2O_7$: 0.1% Eu; (b) $Sr_2P_2O_7$: 0.5% Eu; (c) $Sr_2P_2O_7$: 1.0% Eu; (d) $Sr_2P_2O_7$: 1.5% Eu (e) $Sr_2P_2O_7$: 2.0% Eu (f) $Sr_2P_2O_7$: 2.5% Eu (g) $Sr_2P_2O_7$: 5.0% Eu.

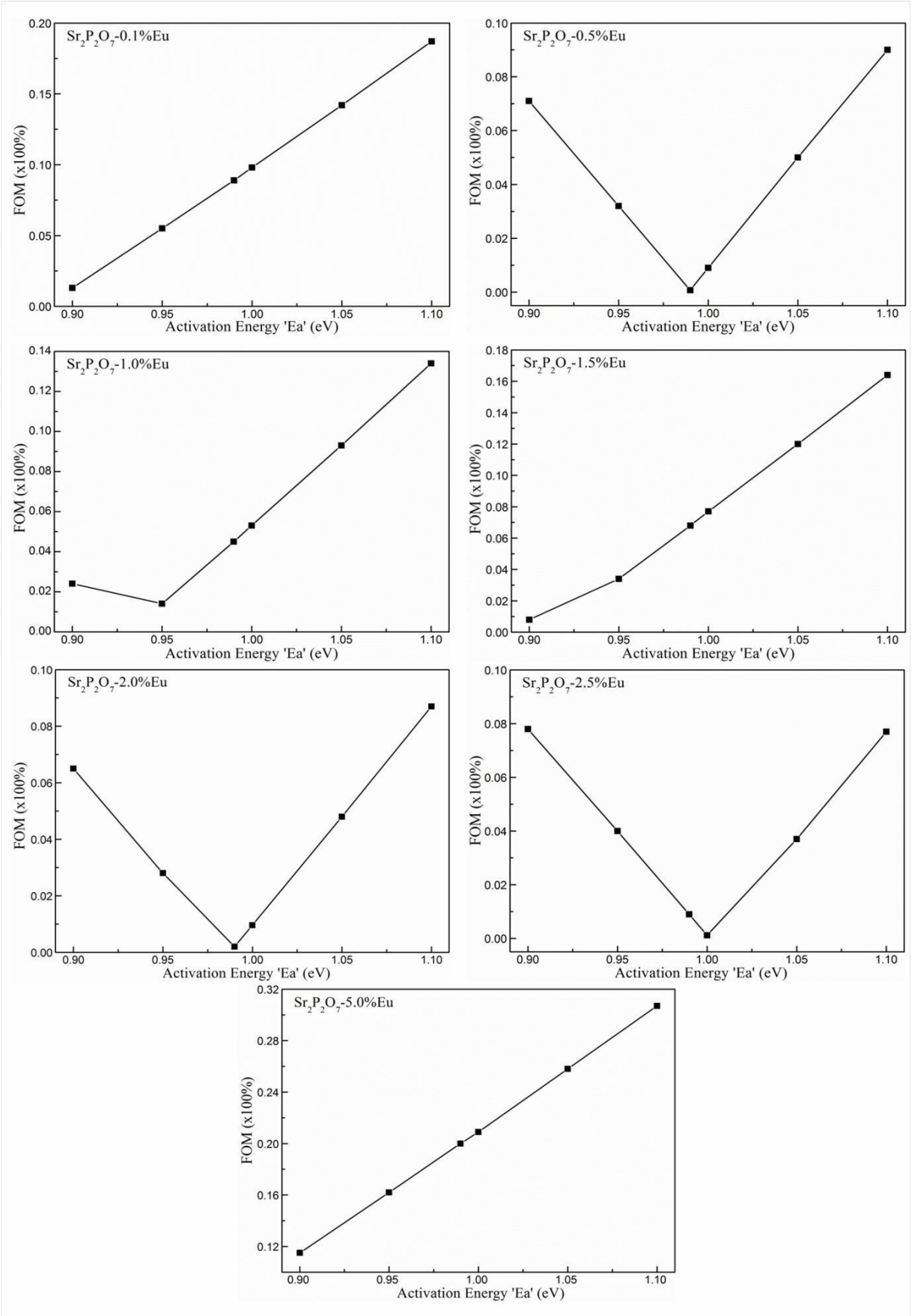

Figure 5. Figure of merit (FOM)→Activation energy (E_a) graphs of Eu^{3+} doped $Sr_2P_2O_7$ analyzed by Kitis et al. equation of second-order kinetics.

Sample	Order of Kinetics (b)	Activation Energy 'E_a' (eV)	Regression Coefficient R^2
$Sr_2P_2O_7$: 0.1%Eu	1.8	0.92 ± 0.01	0.9940
	1.9	0.97 ± 0.01	0.9956
	2.0	1.02 ± 0.01	0.9960
	2.1	1.06 ± 0.01	0.9955
$Sr_2P_2O_7$: 0.5%Eu	1.8	1.04 ± 0.01	0.9982
	1.9	1.08 ± 0.01	0.9981
	2.0	1.13 ± 0.01	0.9972
	2.1	1.17 ± 0.01	0.9956
$Sr_2P_2O_7$: 1.0%Eu	1.8	0.83 ± 0.01	0.9932
	1.9	0.88 ± 0.01	0.9942
	2.0	0.92 ± 0.01	0.9943
	2.1	0.97 ± 0.01	0.9934
$Sr_2P_2O_7$: 1.5%Eu	1.8	0.70 ± 0.01	0.9881
	1.9	0.75 ± 0.01	0.9902
	2.0	0.79 ± 0.01	0.9908
	2.1	0.84 ± 0.01	0.9903
$Sr_2P_2O_7$: 2.0%Eu	1.8	0.82 ± 0.01	0.9940
	1.9	0.86 ± 0.01	0.9956
	2.0	0.91 ± 0.01	0.9959
	2.1	0.95 ± 0.01	0.9950
$Sr_2P_2O_7$: 2.5%Eu	1.8	0.93 ± 0.01	0.9976
	1.9	0.98 ± 0.01	0.9986
	2.0	1.04 ± 0.01	0.9984
	2.1	1.09 ± 0.01	0.9972

Table 1. Summary of TL glow curves parameters of $Sr_2P_2O_7$: xEu (x=0.1, 0.5, 1.0, 1.5, 2.0, 2.5, 5.0 mol%) calculated by whole curve method with statistical confirmation.

Sample	Activation Energy 'E$_a$' (eV)	FOM (%)
$Sr_2P_2O_7$: 0.1%Eu	0.90	1.3
	0.95	5.5
	0.99	8.9
	1.00	9.8
	1.05	14.2
	1.10	18.7
$Sr_2P_2O_7$: 0.5%Eu	0.90	7.1
	0.95	3.2
	0.99	0.07
	1.00	0.9
	1.05	5.0
	1.10	9.0
$Sr_2P_2O_7$: 1.0%Eu	0.90	2.4
	0.95	1.4
	0.99	4.5
	1.00	5.3
	1.05	9.3
	1.10	13.4
$Sr_2P_2O_7$: 1.5%Eu	0.90	0.8
	0.95	3.4
	0.99	6.8
	1.00	7.7
	1.05	12.0
	1.10	16.4
$Sr_2P_2O_7$: 2.0%Eu	0.90	6.5
	0.95	2.8
	0.99	0.2
	1.00	0.96
	1.05	4.8
	1.10	8.7
$Sr_2P_2O_7$: 2.5%Eu	0.90	7.8
	0.95	4.0
	0.99	0.9
	1.00	0.12
	1.05	3.7
	1.10	7.7
$Sr_2P_2O_7$: 5.0%Eu	0.90	11.5
	0.95	16.5
	0.99	20.0
	1.00	20.9
	1.05	15.8
	1.10	30.7

Table 2. Summary of TL glow curves parameters of $Sr_2P_2O_7$: xEu (x=0.1, 0.5, 1.0, 1.5, 2.0, 2.5, 5.0 mol%) calculated by Kitis et al. equation of second-order kinetics for curve fitting.