Supplementary Information

Photoluminescence, persistent luminescence and thermoluminescence studies of Cr-doped zinc gallogermanate (ZGGO:Cr)

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S1. Thermoluminescence model: fitting parameters

This section of the supplementary information file presents the fitting parameters used in Figure 6 of the main manuscript, according to the thermoluminescence (TL) model based on a continuous density of states (DOS) within the bandgap which can be approximated by the sum of three Gaussian functions, as given by Equation (S1). The goodness-of-fit was assessed by the usual TL figure of merit (FOM), as given by Equation (S2) The resulting fitting parameters are summarised in Tables S1 and S2, respectively.

$$I(T) = c_1 + c_2\, exp(c_3 T) + \int_{E_{min}}^{E_{max}} \frac{s}{\beta} exp\left(-\frac{E}{kT}\right) exp\left[-\frac{skT^2}{\beta E} exp\left(-\frac{E}{kT}\right)\left(1 - \frac{2kT}{E}\right)\right] \sum_{i=1}^{3} n_{0i} exp\left[-\frac{1}{2}\left(\frac{E-\mu_i}{\sigma_i}\right)^2\right] dE. \tag{S1}$$

$$FOM = \frac{\sum_{T}|I_{exp}(T) - I_{fit}(T)|}{\sum_{T}I_{exp}(T)} \times 100\%,\qquad (S2)$$

Table S1. Fitting parameters of the fits shown in Figure 6a) of the main manuscript, according to Equations (3–5), and respective FOM, as computed from Equation (6).

t	0 min	5 min	10 min	20 min	40 min	1 h	2 h	4 h	8 h	16 h	19 h	48 h	96 h
μ_1 (eV)	0.823	0.826	0.823	0.834	0.839	0.843	0.852	0.862	0.873	0.883	0.891	0.916	0.926
μ_2 (eV)	0.919	0.919	0.919	0.923	0.926	0.929	0.935	0.944	0.953	0.960	0.967	0.988	0.996
μ_3 (eV)	1.01	1.01	1.01	1.02	1.03	1.02	1.03	1.04	1.05	1.05	1.06	1.08	1.09
σ_1 ($\times 10^2$ eV)	4.05	3.69	4.01	3.35	3.09	2.98	2.79	2.61	2.50	2.27	2.25	2.19	2.07
σ_2 ($\times 10^2$ eV)	6.75	6.36	6.73	5.96	5.70	5.59	5.37	5.20	5.03	4.77	4.73	4.46	4.32
σ_3 ($\times 10^2$ eV)	9.18	8.85	9.17	8.49	8.29	8.18	7.99	7.81	7.65	7.39	7.37	7.09	6.95
n_{01} ($\times 10^7$)	11.2	11.6	11.1	11.9	11.9	11.7	11.3	10.7	9.88	9.36	9.23	8.00	6.67
n_{02} ($\times 10^7$)	15.5	15.5	15.6	15.5	15.7	15.6	15.5	15.3	14.8	14.5	14.6	12.9	11.5
n_{03} ($\times 10^7$)	6.81	7.42	6.82	7.70	7.63	7.50	7.25	6.66	6.02	5.69	5.43	4.30	3.93
s (GHz)							6.00						
c_1							8.02×10^{-3}						
c_2							2.85						

Table S2. Fitting parameters of the fits shown in Figure 6d) of the main manuscript, according to Equations (3–5), and respective FOM, as computed from Equation (6).

t (s)	50	100	200	300	500	700	900	1100	1400	1700	2000	2400	2800	3000	3400	3800	4000
μ_1 (eV)	0.833	0.834	0.846	0.839	0.836	0.835	0.833	0.832	0.834	0.834	0.831	0.830	0.831	0.830	0.830	0.827	0.829
μ_2 (eV)	1.022	1.013	0.999	0.988	0.977	0.969	0.961	0.955	0.950	0.946	0.936	0.930	0.927	0.924	0.922	0.915	0.918
μ_3 (eV)	—	—	—	—	—	—	—	1.15	1.11	1.09	1.05	1.03	1.03	1.02	1.02	1.01	1.01
σ_1 ($\times 10^2$ eV)	5.55	5.82	6.06	5.66	5.35	5.16	4.86	4.70	4.67	4.57	4.34	4.23	4.16	4.09	3.98	3.84	3.91
σ_2 ($\times 10^2$ eV)	9.81	9.98	7.34	7.87	8.20	8.37	8.41	8.31	8.16	7.85	7.51	7.23	7.03	6.92	6.76	6.51	6.58
σ_3 ($\times 10^2$ eV)	—	—	—	—	—	—	—	12.9	12.1	11.3	10.3	9.91	9.65	9.55	9.42	9.20	9.26
n_{01} ($\times 10^7$)	0.180	0.371	1.14	1.64	2.68	3.64	4.50	5.40	6.94	8.80	9.89	11.7	13.5	14.4	15.9	16.7	18.0
n_{02} ($\times 10^7$)	0.436	0.912	1.79	2.81	4.78	6.68	8.57	10.2	12.3	14.2	15.6	17.4	19.0	19.9	21.5	22.7	23.7
n_{03} ($\times 10^7$)	—	—	—	—	—	—	—	1.37	1.70	2.24	3.75	5.06	6.20	6.85	7.81	9.75	9.01
s (GHz)								6.00									
c_1								8.02×10^{-3}									

c_2	2.85															
c_3 (K⁻¹)	1.09×10^{-2}															
FOM (%)	4.93	3.35	2.88	2.41	1.92	1.87	1.76	1.78	1.74	1.78	1.74	1.73	1.77	1.78	1.85	1.83	1.82