

Supporting Materials

Optimization of ZnGa₂O₄:Cr³⁺ Nanoparticles Synthesis Exhibiting Persistent Luminescence for Nanoplastic Labelling and Imaging in *Daphnia magna*

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1. Structure and morphology of $\text{ZnGa}_2\text{O}_4:\text{Cr}^{3+}$ nanoparticles

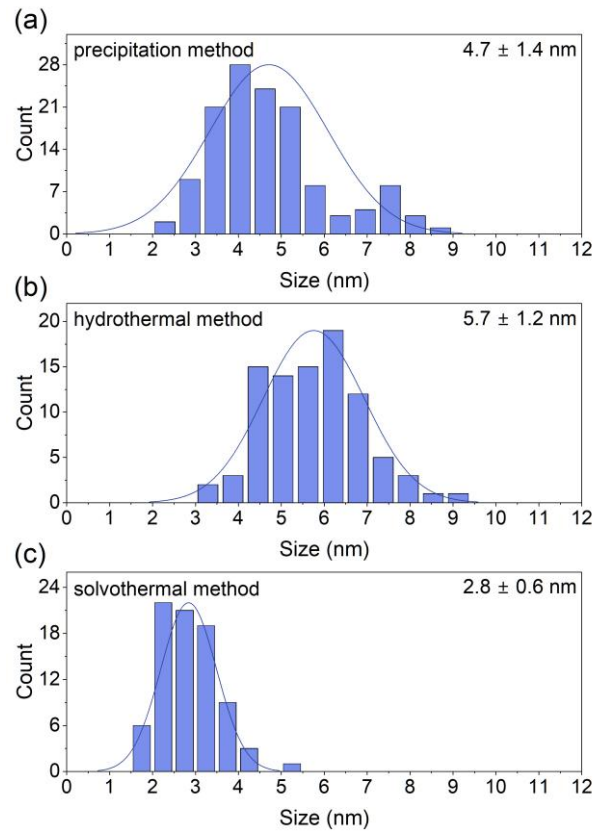


Fig. S1. Distribution of NPs' sizes derived from the TEM images shown in Fig. 1 of the article: (a) presents the histogram for products obtained by the precipitation method, (b) for products synthesized by the hydrothermal method, and (c) for products obtained via the solvothermal method.

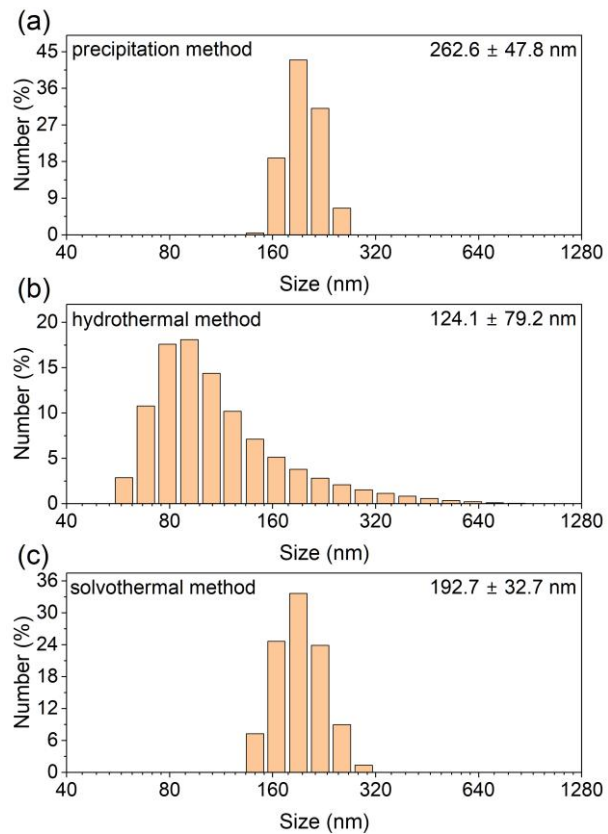


Fig. S2. ZnGa₂O₄:Cr³⁺ NPs' sizes measured in water colloids by DLS method: (a) histograms of the NPs obtained by the precipitation method, (b) for products synthesized by the hydrothermal method, and (c) for products obtained via the solvothermal method.

Table S1. Ions concentrations in all of the obtained materials determined by ICP-MS.

Synthesis method	Synthesis ions ratios Zn:Ga:Cr	ICP-MS ions concentrations			ICP-MS-based ions ratios Zn:Ga:Cr
		Zn (ppm)	Ga (ppm)	Cr (ppb)	
Sol-gel	1:2.2:0.004	356.5	461.9	2466	1:1.3:0.0069
hydrothermal	1:2.2:0.004	276.1	573.8	655.1	1:2.1:0.0024
solvothermal	1:2.2:0.004	227.3	484.3	639.9	1:2.1:0.0028
	1:2.2:0.000	135.2	343.7	59.3	1:2.5:0.0004
	1:2.2:0.001	153.9	372	158.7	1:2.4:0.0010
	1:2.2:0.002	166.2	400.4	220.9	1:2.4:0.0013
	1:2.2:0.003	190.9	469.5	402.8	1:2.5:0.0021
	1:2.2:0.004	173.3	417.6	501.4	1:2.4:0.0029
	1:2.2:0.005	178.2	431.2	597.1	1:2.4:0.0034
	1:2.2:0.006	148.3	357.2	643.1	1:2.4:0.0043
	1:2.2:0.004	227.3	484.3	639.9	1:2.1:0.0028
	1:2.0:0.004	117.6	225.7	445.3	1:1.9:0.0038
	1:1.8:0.004	187.7	298.7	611.7	1:1.6:0.0033
	1:2.2:0.0036	178.2	370.6	491.4	1:2.1:0.0028
	1:2.0:0.0032	183.4	341	484.9	1:1.9:0.0026
	1:1.8:0.0028	180.8	289.9	436.1	1:1.6:0.0024

2. Characterization of polystyrene microparticles doped with $\text{ZnGa}_2\text{O}_4:\text{Cr}^{3+}$ nanoparticles

(PS: 2% ZGO)

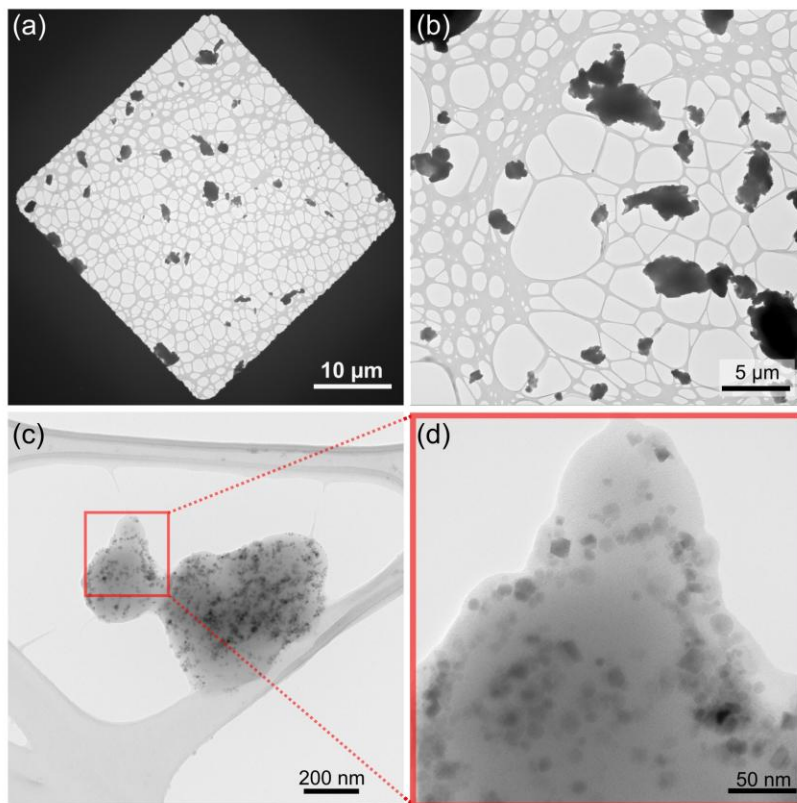


Fig. S3. TEM images of PS: 2% ZGO.

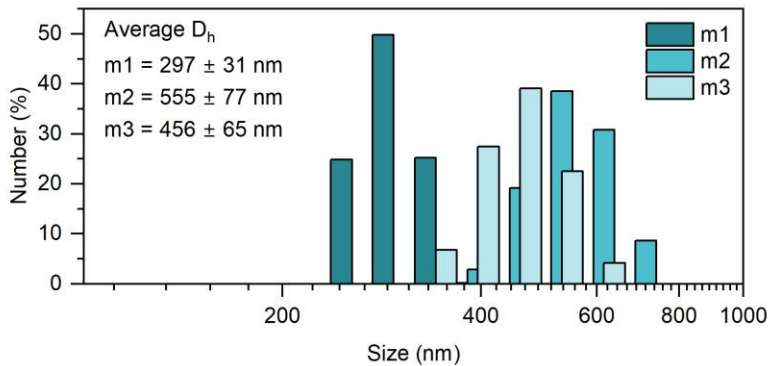


Fig. S4. Hydrodynamic sizes distribution of PS: 2% ZGO measured using the DLS technique (m1-m3 correspond to measurements 1-3).

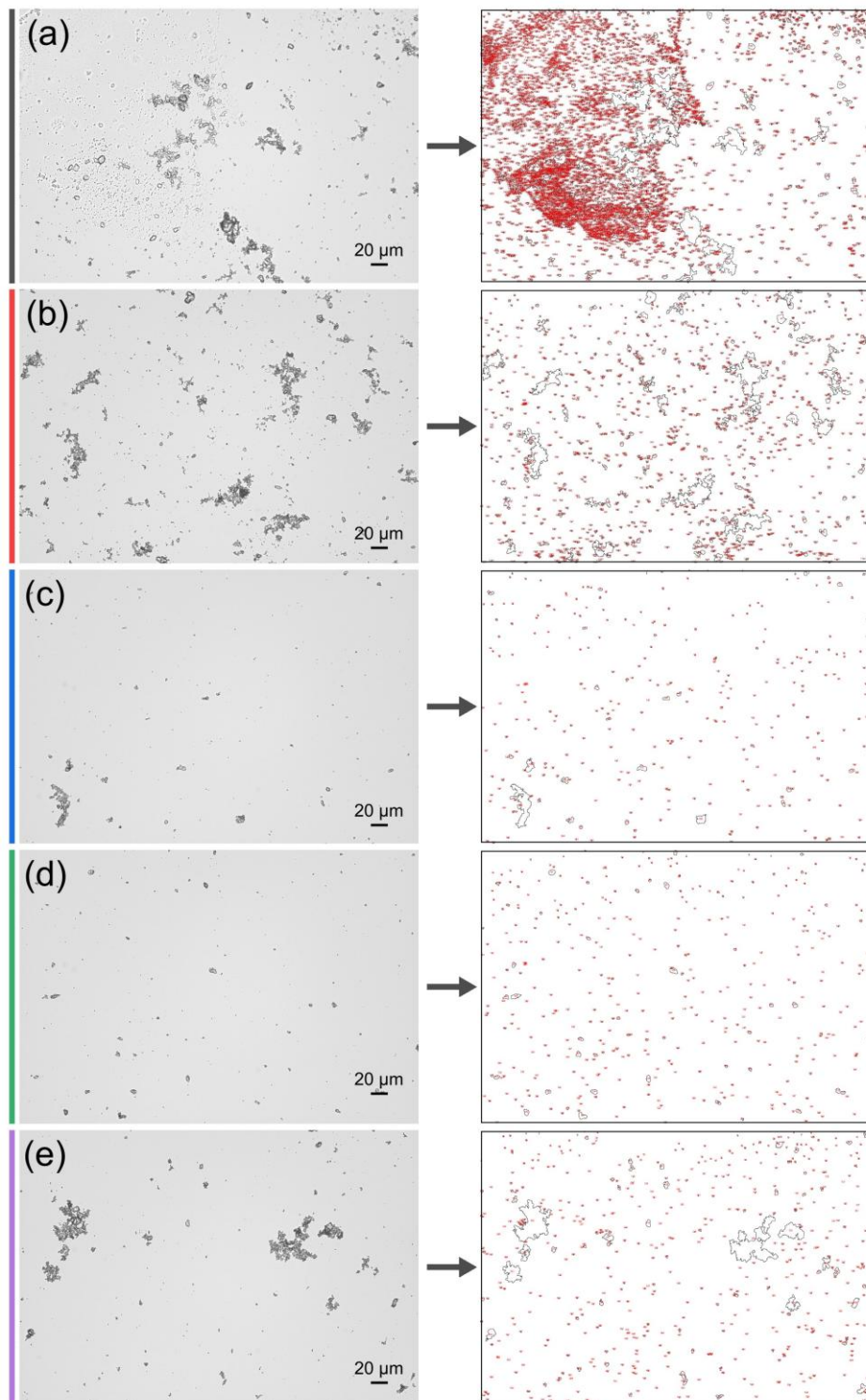


Fig. S5. Brightfield microscope images of PS: 2% ZGO acquired using the Plan Apo 20 \times objective (left column) and corresponding processed images showing particle outlines (right column). The labels (a-e) correspond to the legends in Table S2 and Fig. S6.

Table S2. Summary of the Feret diameter and perimeter calculations.

Image	Particle count	Mean Feret diameter (μm)	Mean perimeter (μm)	Fraction of particles $<1 \mu\text{m}$
a	4794	1.618	4.194	38%
b	1134	2.696	8.366	18%
c	306	2.252	6.210	16%
d	387	1.889	4.658	27%
e	549	2.218	6.988	33%
Average	1434	2.135	6.083	26%

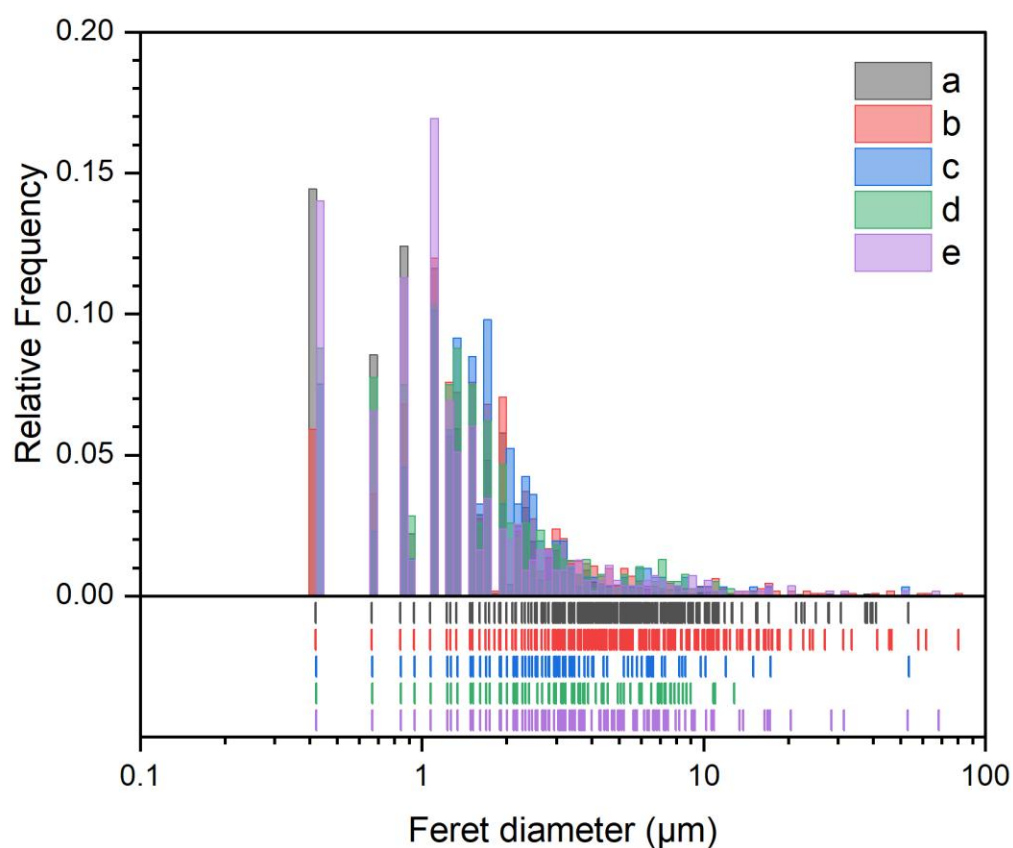


Fig. S6. Feret diameter distribution (histogram of 100 bins) of the PS: 2% ZGO. Plots a-e correspond to the microscope images presented in Fig. S5.

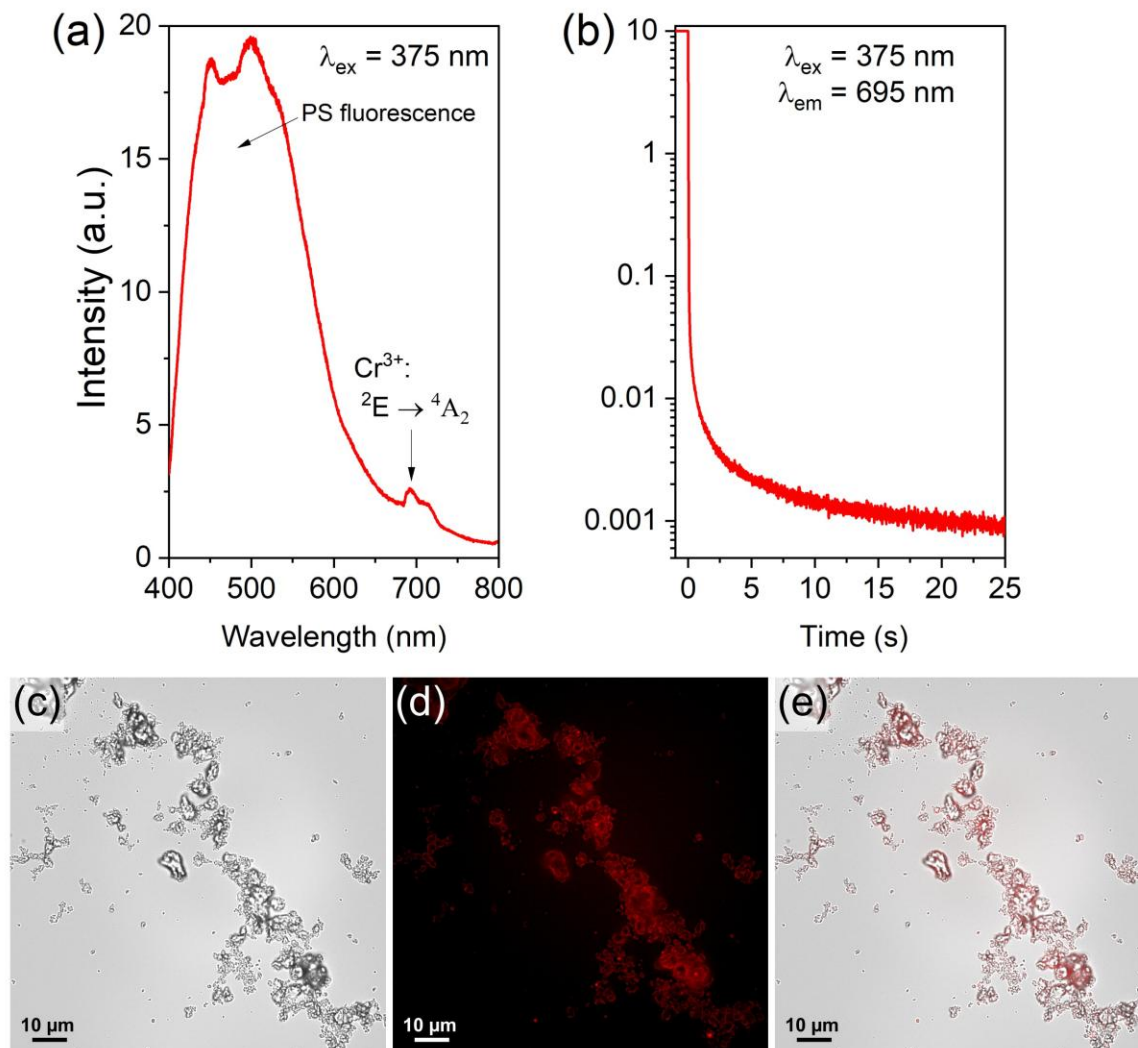


Fig. S7. Luminescence properties of PS:2% ZGO upon 375 nm diode excitation: a) emission spectra, b) persistent luminescence decay ($\lambda_{em} = 695$ nm), and fluorescence microscopy images of the material acquired using the Plan Apo Oil 60 \times objective: c) brightfield mode, d) luminescence upon excitation using 375 nm UV LED collected using a 600 nm long-pass filter, e) overlay.

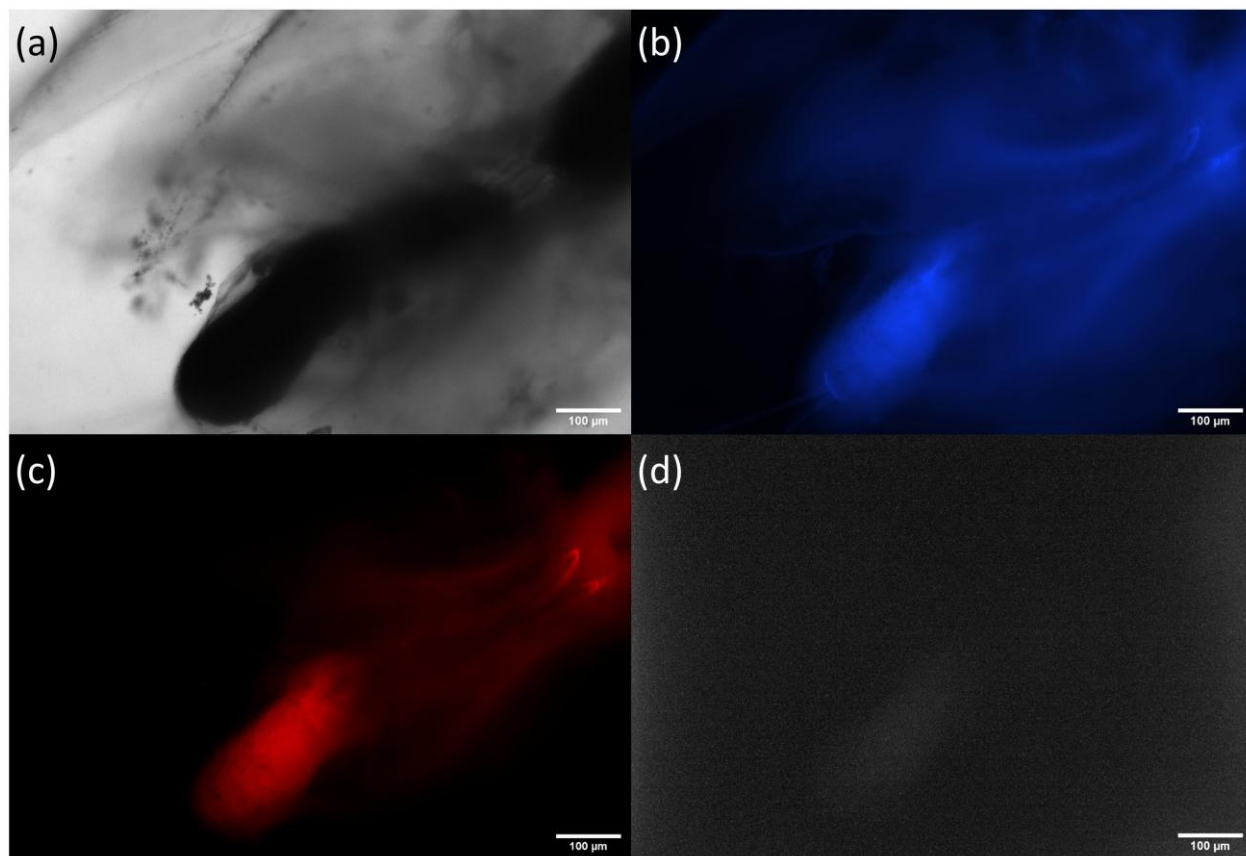


Fig. S8. Fluorescence microscopy images of the guts of *Daphnia magna* incubated in the presence of PS: 2% ZGO at a concentration of 1 mg/mL, acquired using Nikon CFI Achromat 10× objective upon excitation by a 375 nm LED. (a) *Daphnia* observed in brightfield mode. (b) Autofluorescence in the blue spectral range. (c) Emission of Cr^{3+} ions, visualized using a 600 nm long-pass filter. (d) The persistent luminescence of labeled polystyrene microparticles, recorded within 2 seconds after stopping LED illumination using a 600 nm long-pass filter.