

Supporting information

**Optoelectronic inhibitory synapses in the visible range from PbS nanocrystal arrays**

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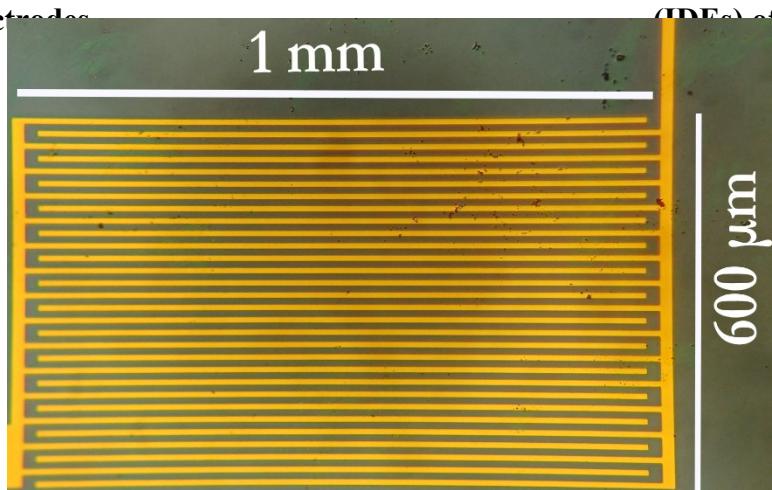
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• **Synthesis of PbS-OA nanoparticles**

The chemicals used for the synthesis of the lead sulfide (PbS) via hot injection with oleic acid ligands were the following: Lead Oxide (PbO, 99+%), Bis(trimethylsilyl)sulfide (TMS, 98%), Oleic acid (OA; 90%), Oleylamine (OAm, 80-90%), 1-Octadecene (ODE, 90%); all purchased from Thermo Fisher Scientific.

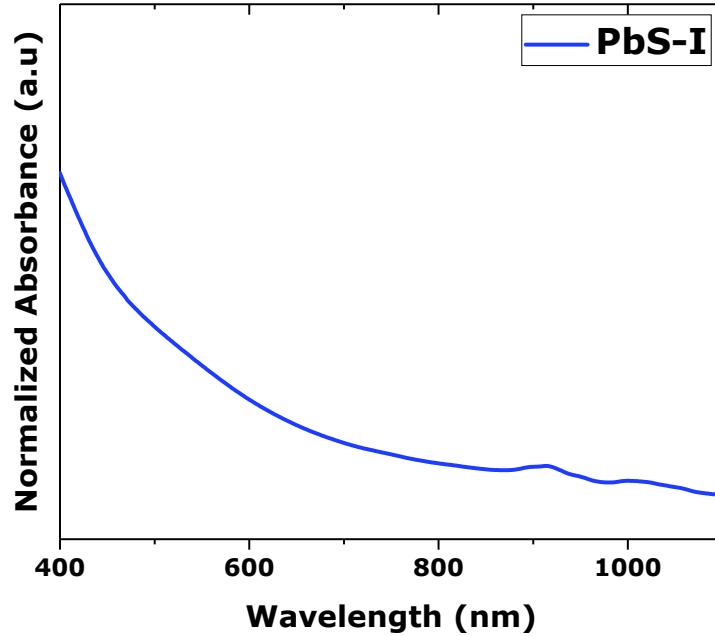
The synthesis of PbS-OA nanoparticles was based on previous reports with alterations.<sup>1</sup> Firstly, 1.35 g of PbO, 9 mL ODE and 5 mL OA were loaded in a three-neck RBF and degassed under vacuum at 100°C for 6 hours to form Pb-oleate complex. After that, 400 µL OAm in 15 mL of ODE was injected into flask. After 30 minutes the flask is backfilled with Argon and 220 µL of TMS in 16.3 mL of ODE was rapidly injected. After the injection the heating mantle was removed, and the reaction was left to cool down to room temperature naturally. 5ml of toluene was added to the flask to collect the product which was then transferred to centrifuge tubes. The quantum dots were precipitated by the addition of acetone and centrifuged at 6k rpm for 10 minutes. The supernatant was discarded and the purification process was repeated two more times. The final solids were dried under vacuum and redispersed anhydrous toluene with a concentration of 20mg/ml for device fabrication.

• **Optical  
the  
Electrodes**



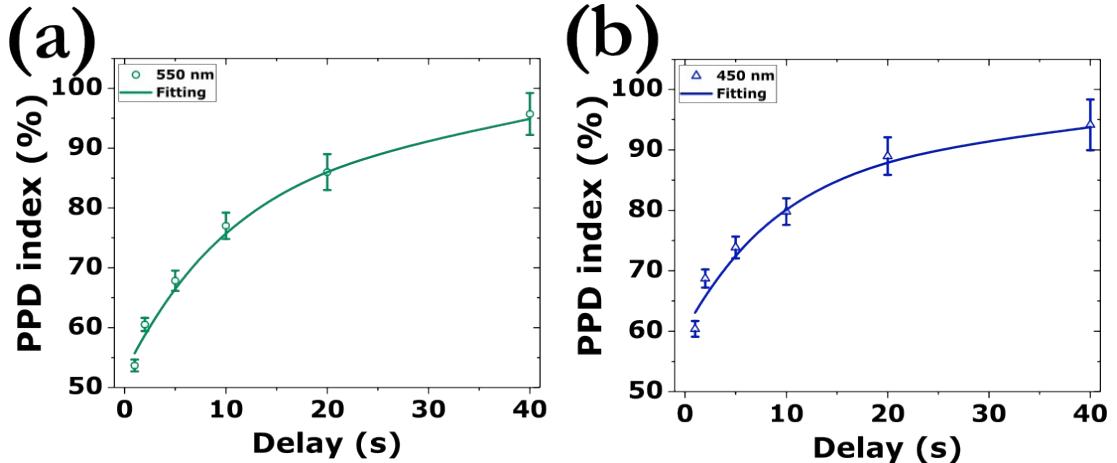
**Figure S1.** Optical microscopy picture of the interdigitated electrodes of the fabricated device with an inter-finger spacing of 10 µm.

- Absorbance spectrum



*Figure S2:* Normalized absorbance spectrum of PbS-I nanocrystals.

- Paired Pulsed Depression (PPD) index



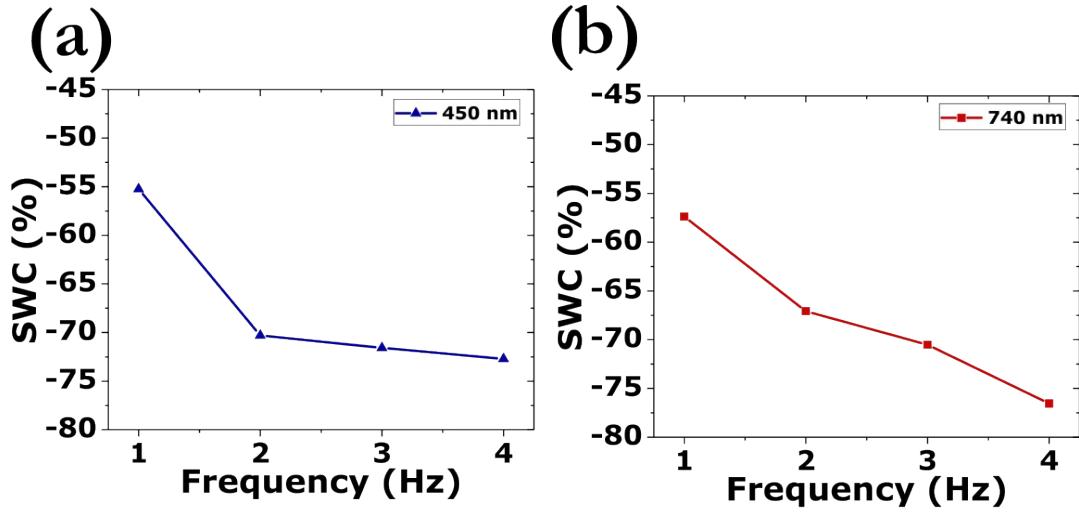
*Figure S3:* Distribution of the PPD index as a function of the pulse interval (Delay  $\Delta t$ ) of the optical pulses for 550 nm (a) and 450 nm (b) illumination.

The dependence on the time interval follows a mono-exponential function:

$$PPD = C_1 e^{\left( -\frac{t}{\tau} \right)} \quad (1)$$

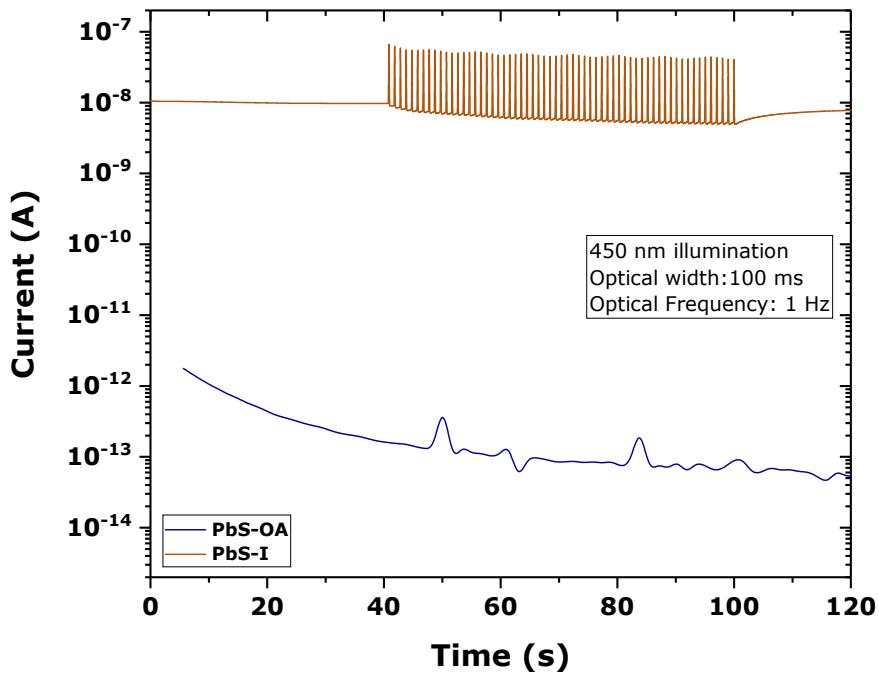
where  $C_1$  is a fitting constant, and  $\tau$  represents the relaxation time associated with this effect. From our analysis, the relaxation time  $\tau$  is estimated to be 12.6 s and 10.7 s for 550 nm and 450 nm illumination respectively.

- **Synaptic Weight Change (SWC) index**



**Figure S4:** The plot of synaptic weight via the pulse frequency for 450 nm (a) and 740 nm (b) light illumination (pulse width: 200 ms, intensity: 1.22 mW/cm<sup>2</sup>).

- **Inhibitory Post Synaptic Current (IPSC) for PbS-OA and PbS-I QDs**



**Figure S5:** IPSC triggered by stimulus trains for 450 nm illumination in the case of PbS-OA (blue line) and PbS-I (brown line) QDs. The optical frequency of the irradiation was 1 Hz, while the optical width of the pulses was set to 100 ms. The optical intensity was measured to be 1.22 mW/cm<sup>2</sup>.

**Table S1:** Performance comparison of optical inhibitory synaptic devices.

Device	Light Stimuli for inhibition	Stimulus mode for inhibition	Energy consumption	PPD	Reference
2D Bi <sub>2</sub> O <sub>2</sub> Se/ Graphene Hybrid Structure	365 nm	optical	~4.7 fJ	~100 – 190 %	2
Epitaxial scandium nitride (ScN)	365 nm	optical	~30 pJ	~90-16 0 %	3
Organic heterojunction P(VDF-TrFE)/ CuPc/ F <sub>16</sub> CuPc	660 nm	optical	~2.76 pJ	~83-10 0%	4
SnO <sub>2</sub> /CsPbBr <sub>3</sub> QDs heterostructures	365 & 405 nm	electrical	~2 nJ	~90.1- 98.6 %	5
ZnAlSnO/SnS heterostructure	370 & 630 nm	optical	~0.75 pJ	~101-1 11%	6
SnO <sub>2</sub> /Cs <sub>2</sub> AgBiBr <sub>6</sub> heterojunction	365 nm	optical	~690 fJ	~75-96 %	7
PbS-I QDs	450, 550 & 740 nm	optical	~40-55 nJ	55.1-9 3.4%	<i>This work</i>

## References

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