Supplementary information

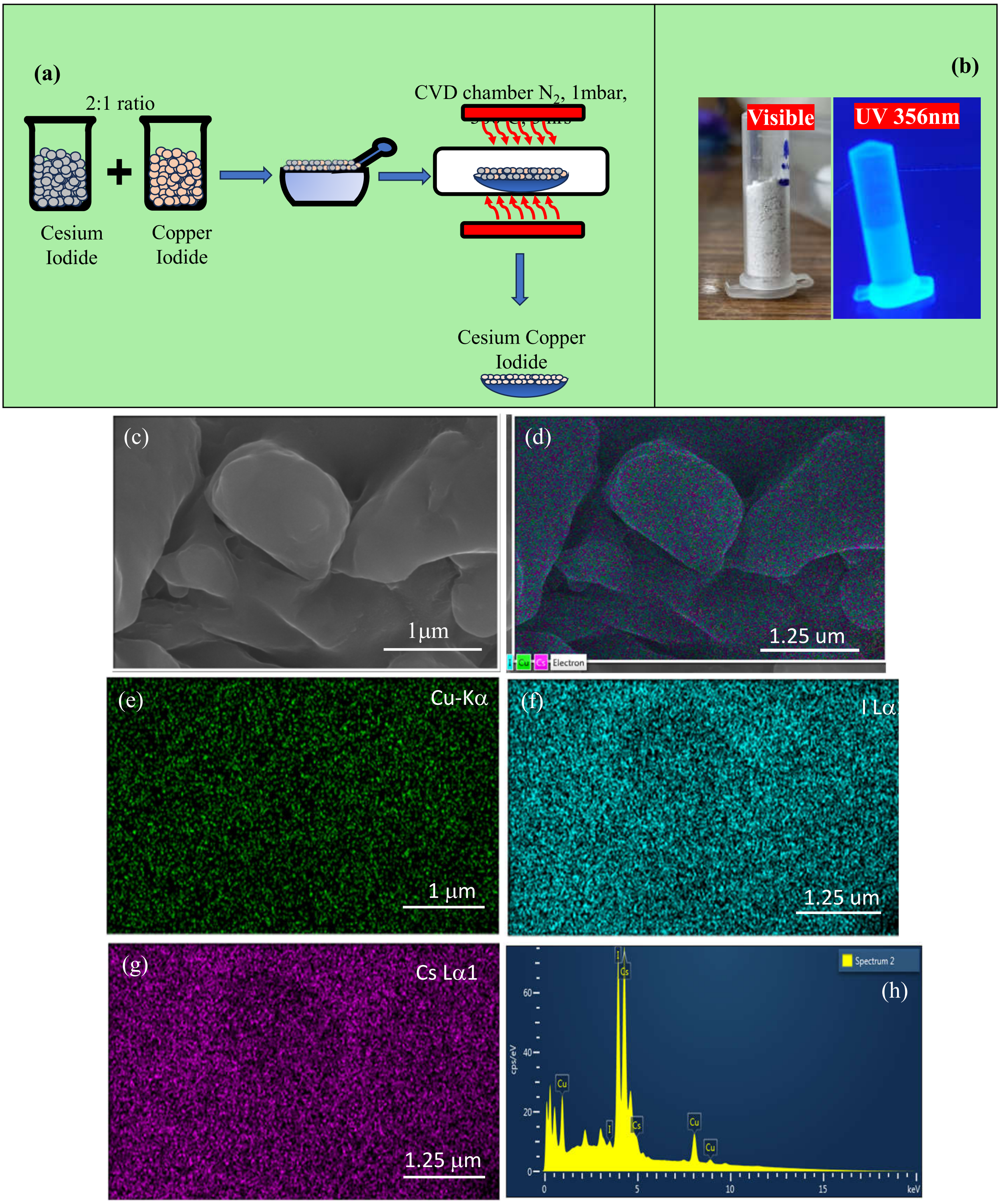
Low energy consuming, optically and electrically stimulated artificial synapse based on lead-free metal halide perovskite ($Cs_3Cu_2I_5$) for neuromorphic applications

Amrita Bharati Mishra[*,§] , *Mrunal Shete*[*,§] *and R. Thamankar* [#]

[*]*Department of Physics, School of Advanced Sciences, Vellore Institute of Technology, Vellore, TN, India*
[#]*Centre for Functional Materials, Vellore Institute of Technology, Vellore, TN, India*

§ Authors with equal contribution

Email : rameshm.thamankar@vit.ac.in



FigureS1: (a)Schematic representation of the synthesis process for the $Cs_3Cu_2I_5$ using CsI:CuI mixture using a solid-state reaction method, including grinding of CsI and CuI in a 2:1 molar ratio followed by annealing at 300°C under 1 millibar pressure in a CVD chamber with nitrogen atmosphere. (b) Shows the synthesized $Cs_3Cu_2I_5$ Metal halide perovskite under visible and UV light. (c) Topographical image of $Cs_3Cu_2I_5$ (Area = 3.95 μm × 2.6 μm). (d) EDAX map containing information about all constituent elements in $Cs_3Cu_2I_5$ (e-g) elemental mapping showing a uniform distribution of each element (copper, Iodine, Cesium respectively) in the sample. (e) EDAX spectra of the sample.

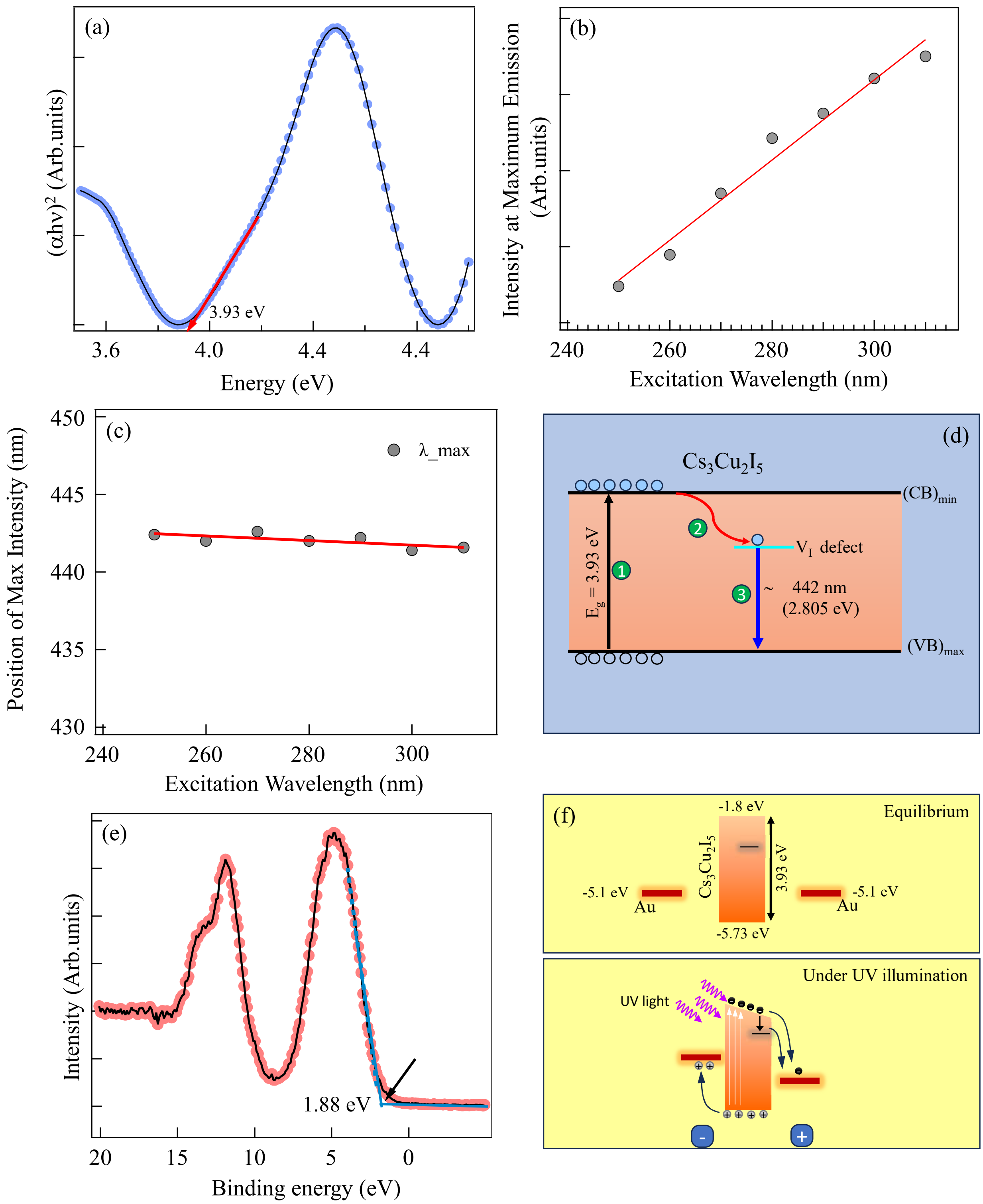
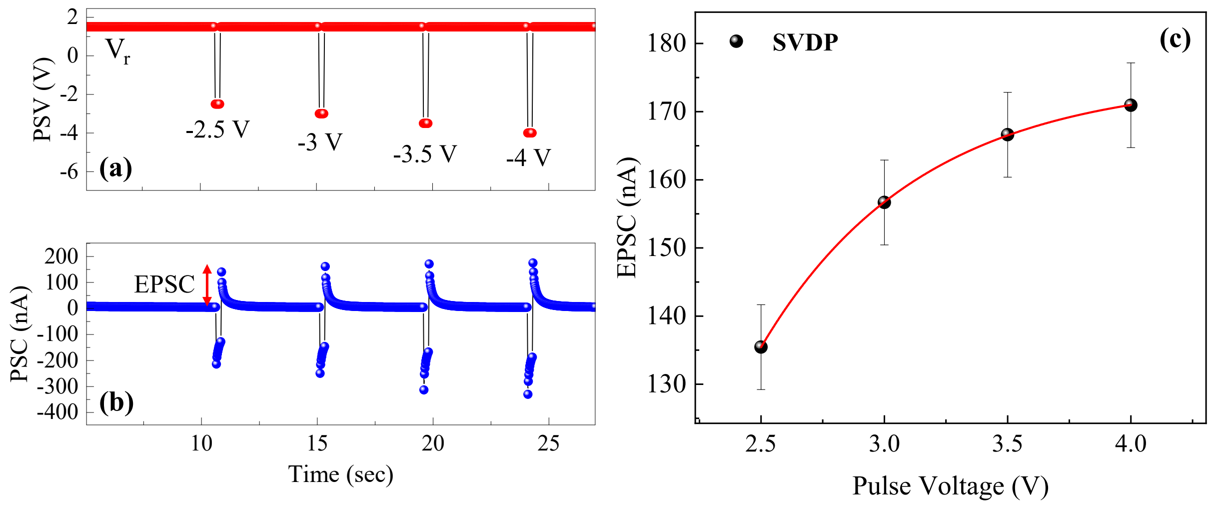


Figure S2 : (a) Tauc plot obtained from UV-vis spectra showing energy gap ~ 3.93 eV for $Cs_3Cu_2I_5$. (b) The results of photoluminescence measurements. Excitation wavelength dependence of the maximum intensity at 442 nm. (c) The position of the maximum intensity with the excitation wavelength. (d) The mechanism of 442 nm emission in $Cs_3Cu_2I_5$. Initially, the electrons will get excited to the conduction band minimum and flowed by a radiation less transition to the defect level located at 2.805 eV above the valence band edge. Further deexcitation takes to the valence band giving out a photon of 442 nm. (e) The high-resolution valence band edge XPS spectra of $Cs_3Cu_2I_5$ showing the difference between the valence band maximum and Fermi energy is about 1.88 eV. (f) Schematic diagram of energy band diagram of Au/ $Cs_3Cu_2I_5$/Au device. The UV photon mediated creation of the electron-hole pair generation is depicted.



FigureS3: Spike voltage dependent plasticity (SVDP). (a) The sequence of applied voltage pulses for the measurement of SVDP (V_p = -2.5 V, -3.0 V, -3.5 V, -4.0 V. The read voltage V_r = 1.5 V is kept constant. (b) Measured excitatory post synaptic current (EPSC) during the voltage pulsing as in (a). For higher negative voltages, there is an increase in the EPSC generated. (c) Dependence of EPSC with respect to varying pulse amplitude. We can see an exponential increase in EPSC with respect to pulse amplitude.