

Table S1. Comparison between EDLCs, pseudocapacitors, and hybrid/photoresponsive supercapacitors.

Feature	EDLC	Pseudocapacitor	Hybrid / Photoresponsive (TiO ₂ /Graphene)	References
Storage mechanism	Electrostatic charge accumulation at the electrode/electrolyte interface (Helmholtz double layer).	Fast, reversible faradaic reactions (surface redox, ion intercalation, electrosorption).	Combination of EDLC (graphene) and pseudocapacitance (TiO ₂), with additional light-induced charge separation enhancing capacitance.	[1]
Typical materials	Activated carbon, CNTs, graphene.	Transition metal oxides (RuO ₂ , MnO ₂ , TiO ₂), conducting polymers (polyaniline, polypyrrole).	TiO ₂ /graphene nanohybrids and other semiconductor-carbon composites capable of photoactivation and sensing.	[2]
Capacitance contribution	Purely surface-dependent, typically 100–200 F g ⁻¹ .	Surface + faradaic contributions; several hundred F g ⁻¹ possible.	Synergistic contributions; ~35% enhancement under UV/visible light in TiO ₂ /graphene hybrids.	[3]
Energy density	Low (5–10 Wh kg ⁻¹).	Higher (10–50 Wh kg ⁻¹ depending on oxide/polymer).	Intermediate-to-high; photoactivation can further boost energy density.	[4]
Power density	Very high (>10 kW kg ⁻¹).	High, but lower than EDLC due to faradaic kinetics.	Balanced: graphene ensures high power, TiO ₂ adds pseudocapacitance, light improves kinetics and charge separation.	[5]
Cycle life	Excellent (>10 ⁵ –10 ⁶ cycles).	Moderate (10 ³ –10 ⁴ cycles), degradation over time.	Dependent on hybrid stability; graphene maintains long cycle life, TiO ₂ /photoactivation adds complexity but remains promising.	[2]
Additional functionalities	None beyond energy storage.	Mainly energy storage only.	Photoresponsivity, VOC/humidity sensing, dual energy-sensing integration for smart systems.	[6]

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