Table 6: Cross-material comparison of confinement-induced band gap shifts in nanostructures.

Material	**Bulk Band Gap**	**Effect of Quantum Confinement**	**Tunable Range**	**Special Notes**
Si	1.1 eV (indirect) [13]	Increases, enhances optical transitions [14]	$\sim 1.1 \rightarrow 2$ eV [15]	Useful for Si-based photonics
Ge	0.66 eV (indirect) [13]	Can approach direct gap, widens to ~ 2 eV [15]	$0.66 \rightarrow \sim 2$ eV [3]	Becomes optically active
ZnO	3.37 eV (direct)	Band gap widens with diameter decrease [18]	$\sim 0.8 \rightarrow 2.15$ eV (nanostructures) [15]	Always semiconducting, good for UV devices
GaN	3.4 eV (direct) [18]	Widens significantly, up to ~ 5 eV [16]	$3.4 \rightarrow \sim 5$ eV	Excellent for high-power UV optoelectronics [11]
TM-Doped NWs	Material-dependent (e.g., ZnO: 3.37 eV)	Magnetic doping introduces spin–charge–photon coupling; modifies optical/electronic properties [10, 11]	Tunable via doping and nanowire size	Applications in spintronics, magneto-optical devices, multifunctional nano-optoelectronics