

Comparisons of the different types of electron sources

Electron source performance comparison				
Emitter type	Thermionic	Thermionic	Cold field emission	Schottky field emission
Cathode material	W	LaB ₆	W (310)	ZrO/W (100)
Operating temperature (K)	2,800	1,900	300	1,800
Cathode radius (nm)	60,000	10,000	≤100	≤1,000
Effective source radius (nm)	15,000	5,000	2.5 (a)	15 (a)
Emission current density (A/cm ²)	3	30	17,000	5,300
Total emission current (μA)	200	80	5	200
Normalized brightness (A/cm ² *sr*kV)	1 × 10 ⁴	1 × 10 ⁵	2 × 10 ⁷	1 × 10 ⁷
Maximum probe current	1,000	1,000	0.2	10
Energy spread at the cathode (eV)	0.59	0.4	0.26	0.31
Energy spread at the gun exit (eV)	1.5–2.5	1.3–2.5	0.3–0.7	0.35–0.7
Beam noise (%)	1	1	10	1
Emission current drift (%/h)	0.1	0.2	5	<0.2
Minimum operating vacuum (hPa)	≤1 × 10 ⁵	≤1 × 10 ⁶	≤1 × 10 ¹⁰	≤1 × 10 ⁸
Cathode life (h)	200	1,000	>2,000	>2,000
Cathode regeneration	Not required	Not required	Every 6 to 8	Not required
Sensitivity to external influences	Minimal	Minimal	High	Low

Source: Adapted from Carl Zeiss SMT Literature.