



Title	Electron microscopy in semiconductor inspection
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Electron microscopy in semiconductor inspection

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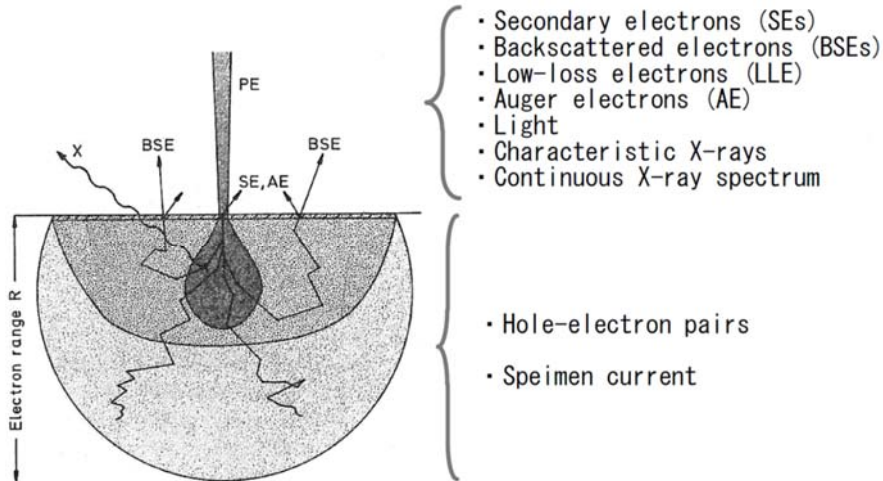


Figure 1 Electron-specimen interactions (left figure reproduced from [11], with the permission of Springer Nature).

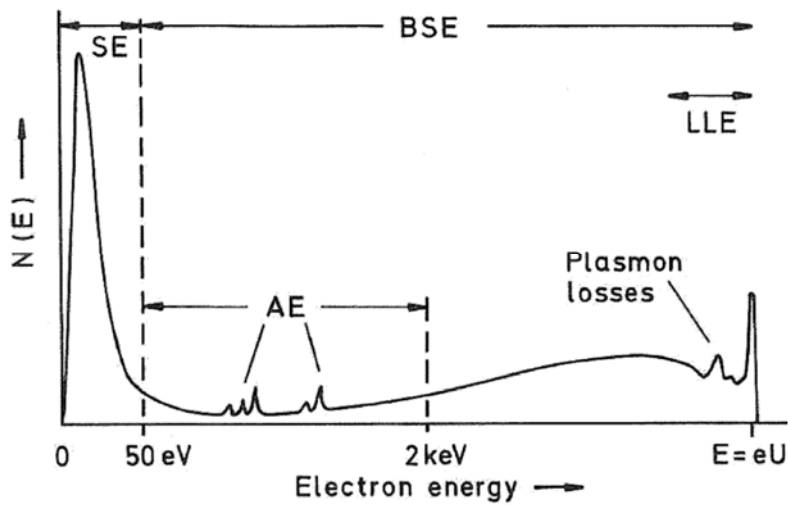


Figure 2 Energy spectrum of electrons emitted (reproduced from [11], with the permission of Springer Nature).
 U is the accelerating voltage.

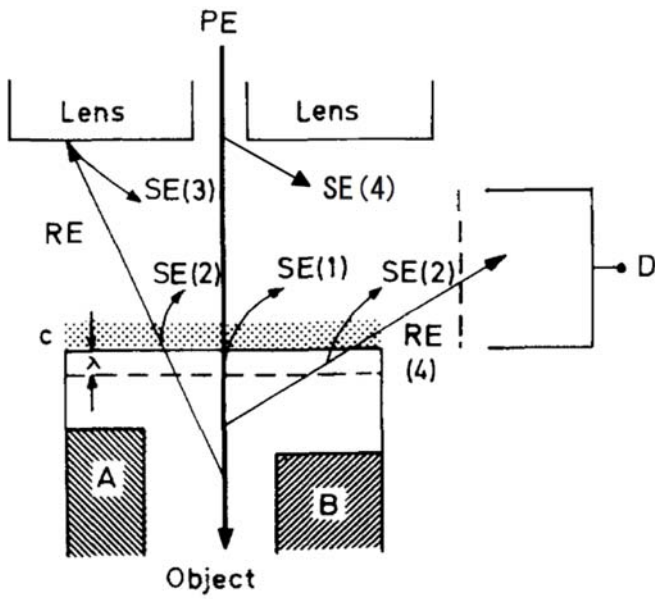


Figure 3. Detection of the SE signal where the specimen surface may be contaminated with layer C (SE(4) is added on the figure reproduced from [14], with the permission of AIP Publishing).

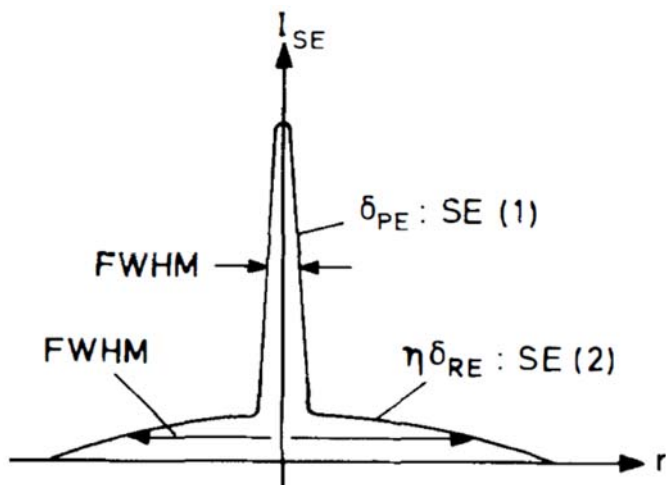


Figure 4 Schematic intensity distribution of the SE (1) and SE (2) depending on the distance r from the impact of the PE. FWHM: Full width at half maximum (reproduced from [14], with the permission of AIP Publishing).

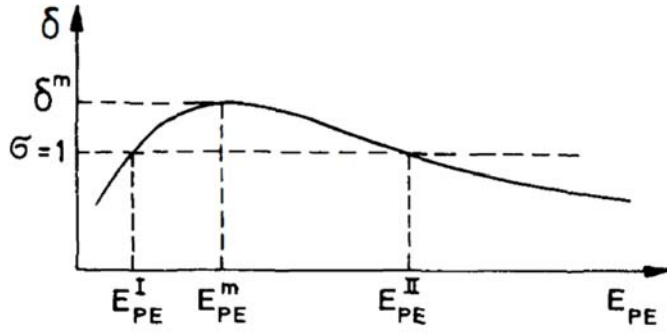


Figure 5 Definitions of E_{PE}^m , δ^m , E_{PE}^I , and E_{PE}^{II} (reproduced from [14], with the permission of AIP Publishing).

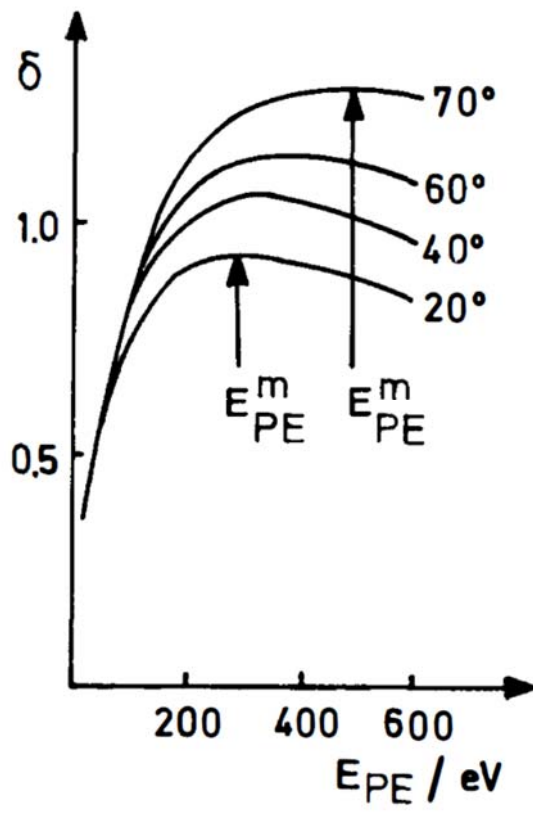


Figure 6 Dependence of δ on the energy of the E_{PE} for different angle of incident (reproduced from [14], with the permission of AIP Publishing).

Table 1 E_{PE}^{II} values (in Figure 5) for materials used in semiconductor device fabrication (reproduced from [15], with the permission of Elsevier Science & Technology Journals).

Semiconductors			
Compound	E_{PE}^{II} (keV)	Compound	E_{PE}^{II} (keV)
Low density resist	0.55	Cr on glass	2
Resist on Cr substrate	0.7	Glass passivation	2
Resist on oxide	0.9	SiO ₂ (quartz)	3
Resist on poly-Si	1.1	Alumina Al ₂ O ₃	2.9
PMMA resist	1.6	High res. GaAs	2.6
Other inorganics			
Compound	E_{PE}^{II} (keV)	Compound	E_{PE}^{II} (keV)
NaCl	2	Pyrex glass	1.9
KCl	1.6	CaF ₂ (fluorite)	1.9
LiF	1.9		

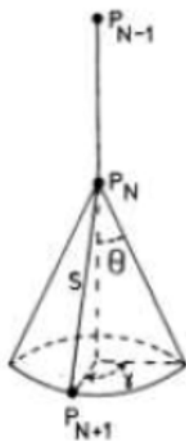


Figure 7. Fundamental calculation step in a Monte Carlo electron trajectory simulation (reproduced from [11], with the permission of Springer Nature).

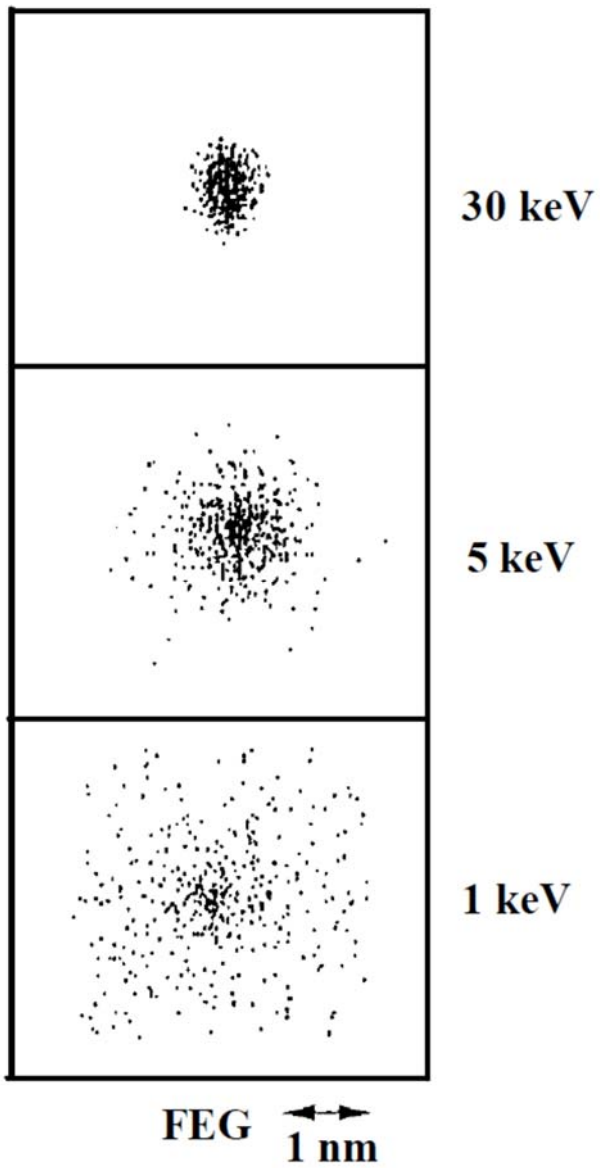


Figure 8 Results of numerical ray tracings for an electron-optical column employing a FEG source, at 1 keV, 5 keV and 30 keV (reproduced from [15], with the permission of Elsevier Science & Technology Journals).

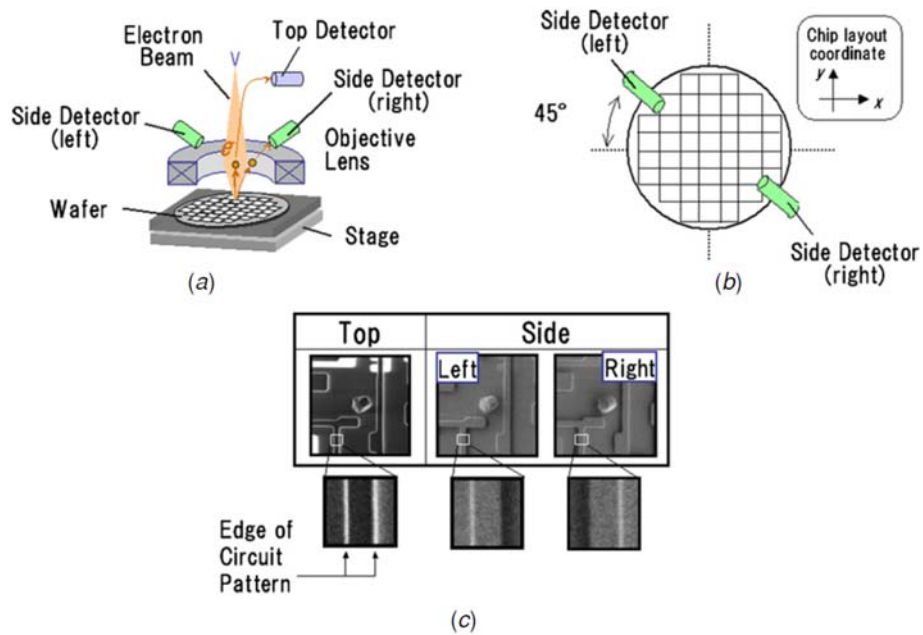


Figure 9 Detector system (three detectors) used in the review SEM: (a) system configuration, (b) layout of side detectors, and (c) example images captured using the three detectors (reproduced from [30], with the permission of IOP Publishing).

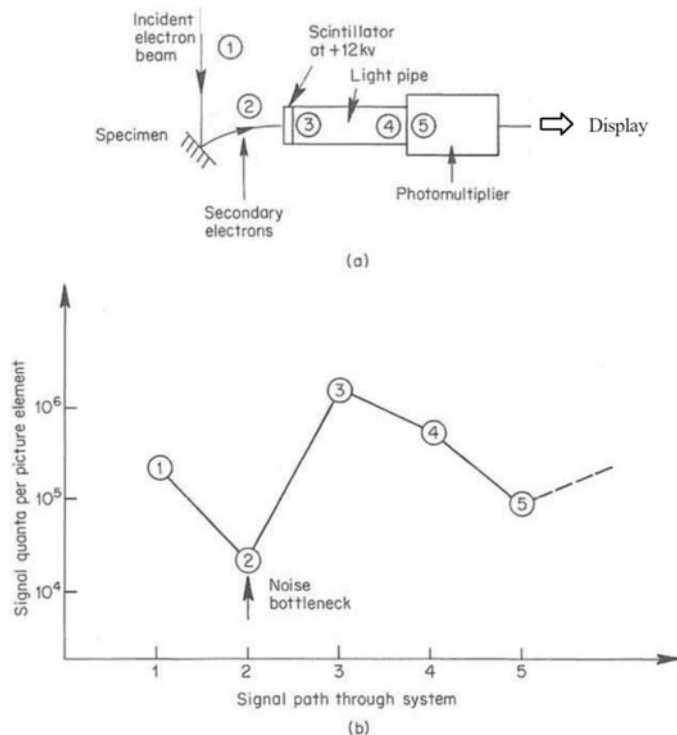


Figure 10 Signal path in SEM with an Everhart-Thornley detector (ETD) (reproduced from [30], with the permission of McGraw-Hill).

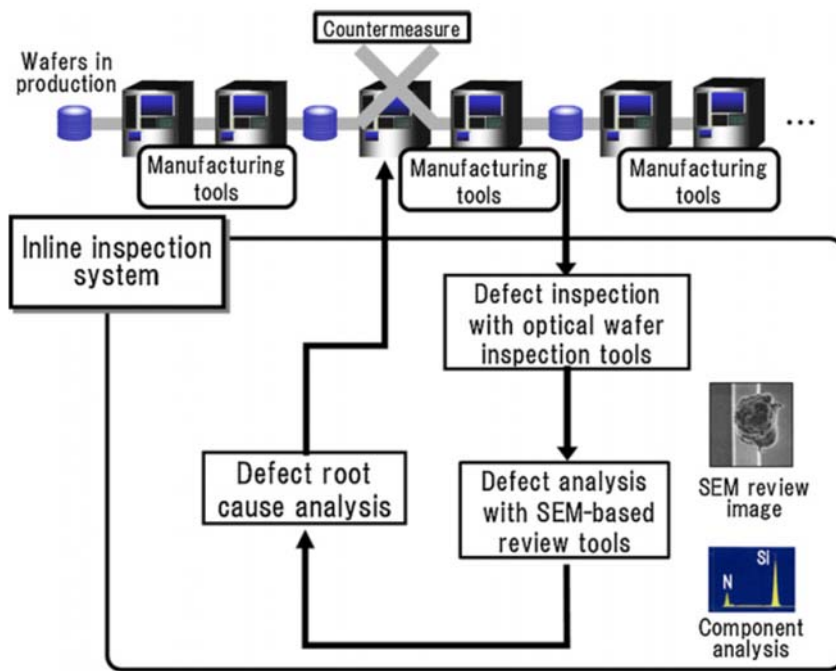


Figure 11. Inline inspection system for semiconductor manufacturing (reproduced from [30], with the permission of IOP Publishing).

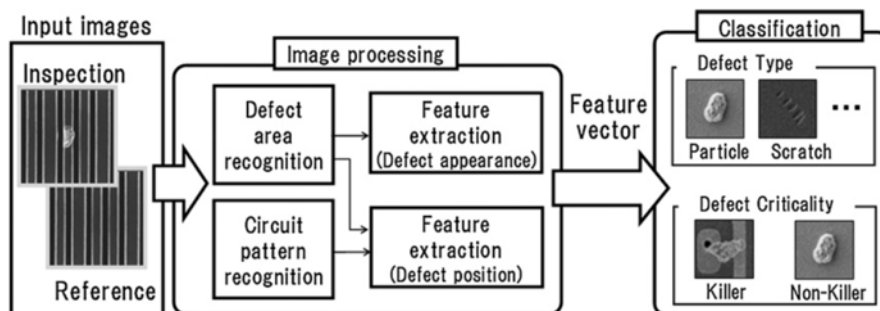


Figure 12. ADC process flow (reproduced from [30], with the permission of IOP Publishing).

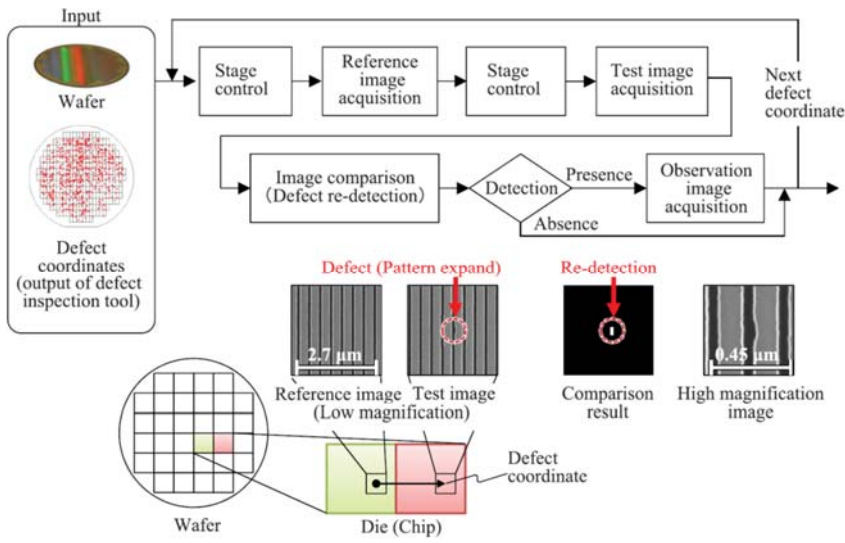


Figure 13 Process flow from optical wafer inspection tools to the ADC (reproduced from [30], with the permission of IOP Publishing).