Electron microscopy in semiconductor inspection

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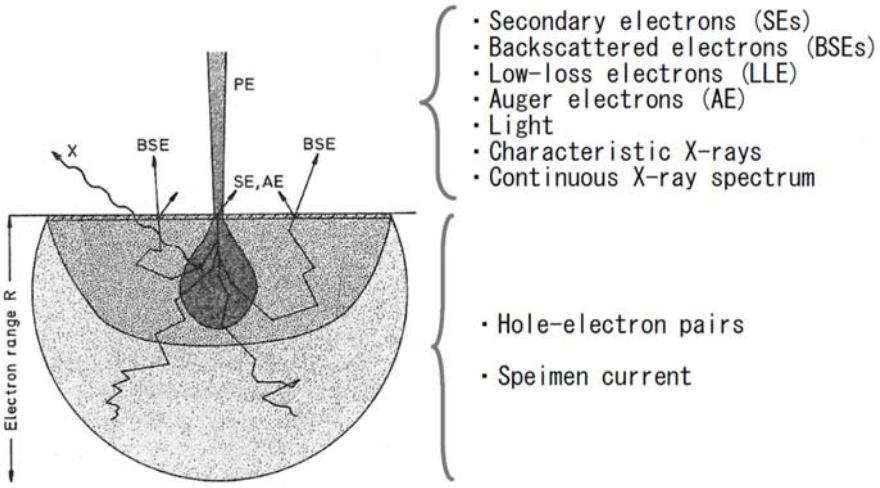

Figure 1 Electron-specimen interactions (left figure reproduced from [11], with the permission of Springer Nature).

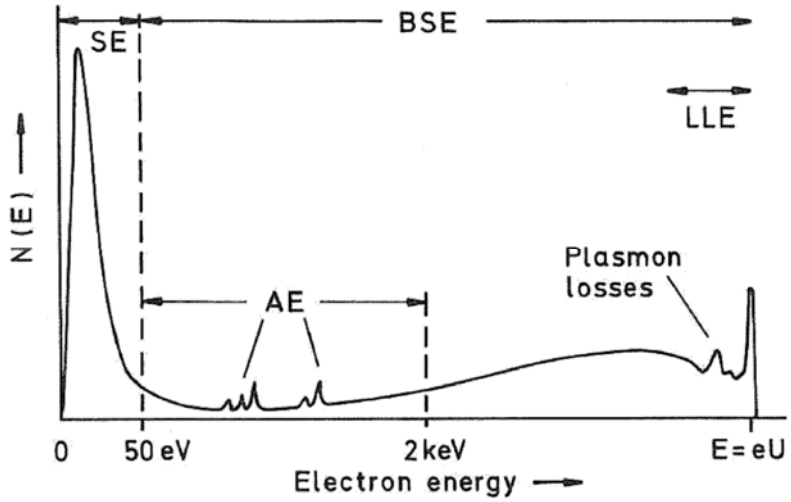

Figure 2 Energy spectrum of electrons emitted (reproduced from [11], with the permission of Springer Nature). U is the accelerating voltage.

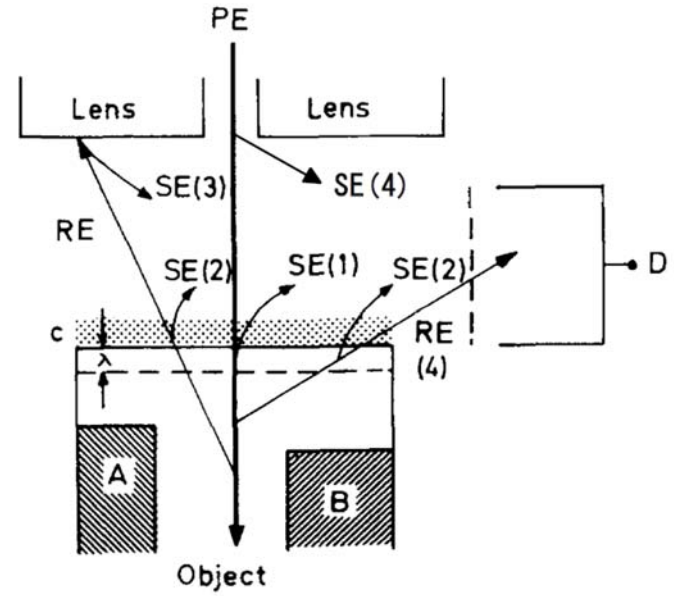

Figure 3. Detection of the SE signal where the specimen surface may be contaminated with layer *C* (SE(4) is added on the figure reproduced from [14], with the permission of AIP Publishing).

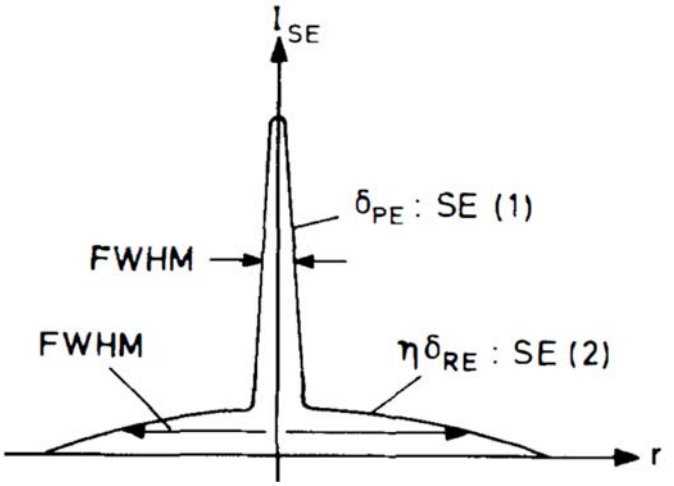

Figure 4 Schematic intensity distribution of the SE (1) and SE (2) depending on the distance ***r*** from the impact of the PE. FWHM: Full width at half maximum (reproduced from [14], with the permission of AIP Publishing).

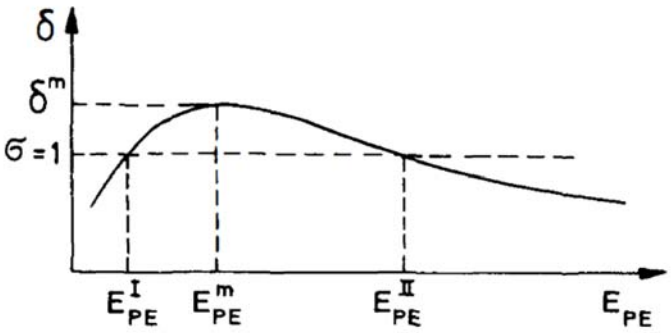

Figure 5 Definitions of E^{m}_{PE}, δ^{m}, E^{I}_{PE}, and E^{II}_{PE} (reproduced from [14], with the permission of AIP Publishing).

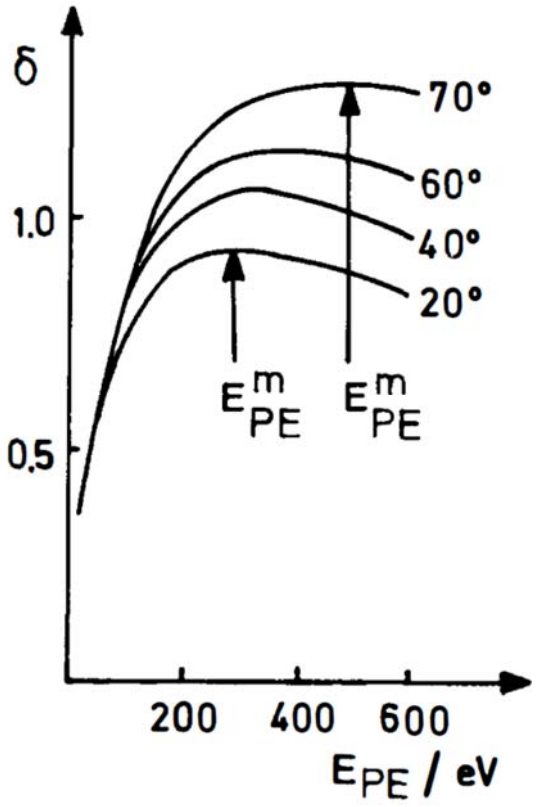

Figure 6 Dependence of δ on the energy of the E_{PE} for different angle of incident (reproduced from [14], with the permission of AIP Publishing).

Table 1 E^{II}_{PE} 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^{II}_{PE} (keV)	Compound	E^{II}_{PE} (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_20_3	2.9
PMMA resist	1.6	High res. GaAs	2.6
Other inorganics			
Compound	E^{II}_{PE} (keV)	Compound	E^{II}_{PE} (keV)
NaCl	2	Pyrex glass	1.9
KC1	1.6	CaF_2(fluorite)	1.9
LiF	1.9		

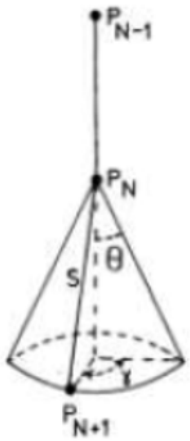

Figure 7. Fundamental calculation step in a Monte Carlo electron trajectory simulation (reproduced from [11], with the permission of Springer Nature).

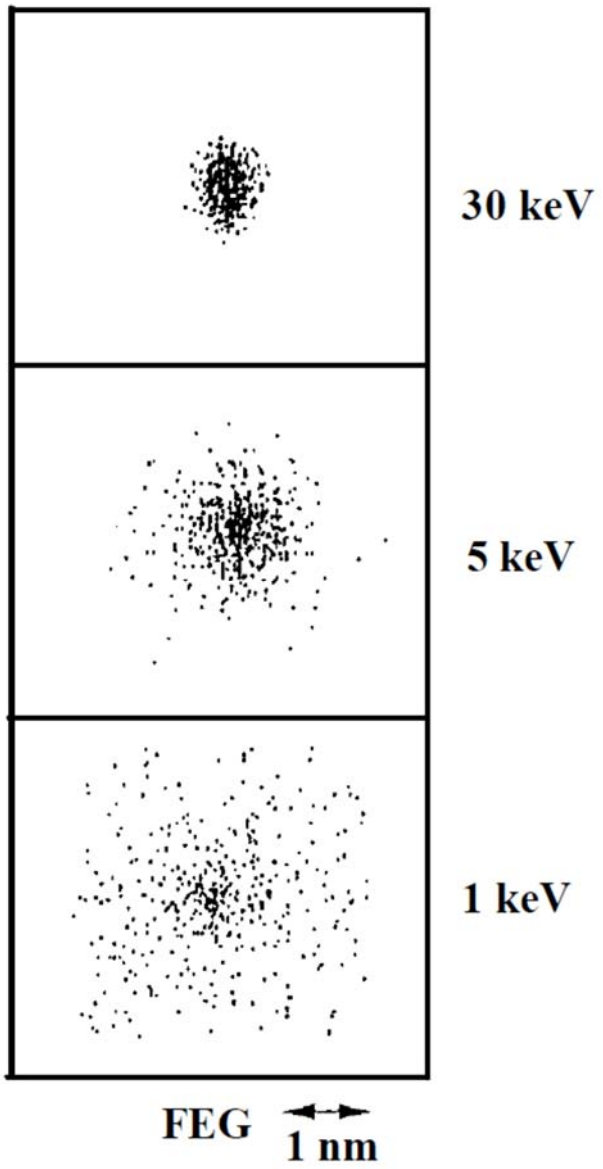

Figure 8 Results of numerical ray tracings for an electron-optical column employing a FEG source, at 1 keV, 5 keV and 30 keV (reproduced from [15], with the permission of Elsevier Science & Technology Journals).

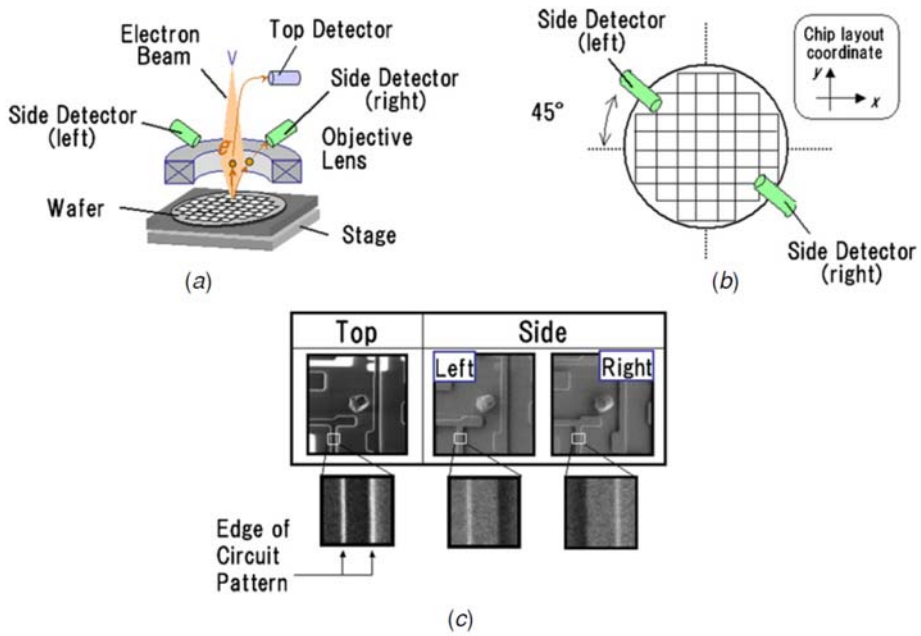

Figure 9 Detector system (three detectors) used in the review SEM: (a) system configuration, (b) layout of side detectors, and (c) example images captured using the three detectors (reproduced from [30], with the permission of IOP Publishing).

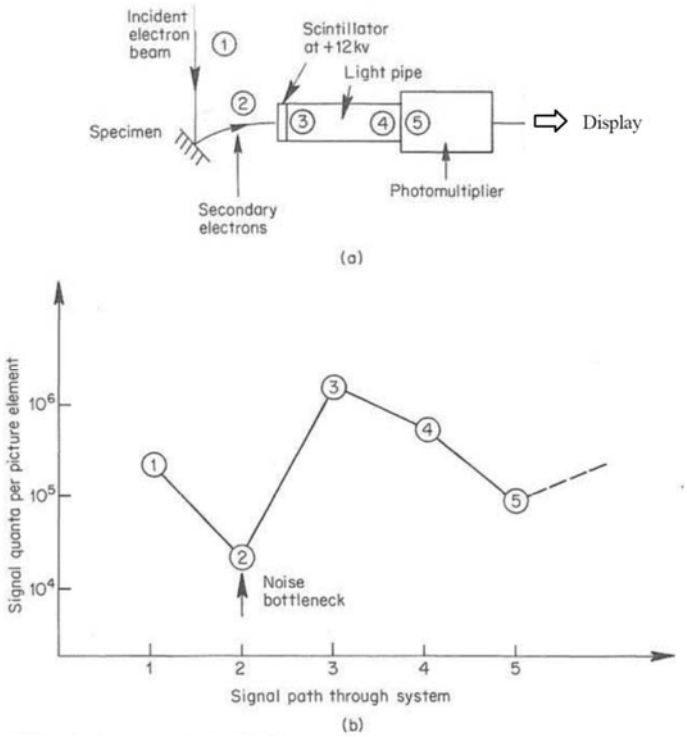

Figure 10 Signal path in SEM with a Everhart-Thornley detector (ETD) (reproduced from [30], with the permission of McGraw-Hill).

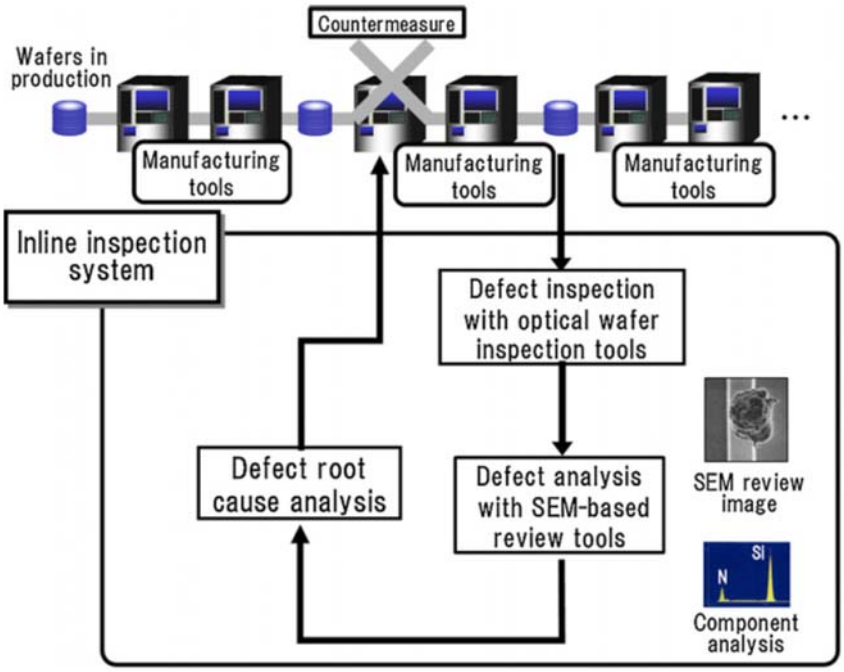

Figure 11. Inline inspection system for semiconductor manufacturing (reproduced from [30], with the permission of IOP Publishing).

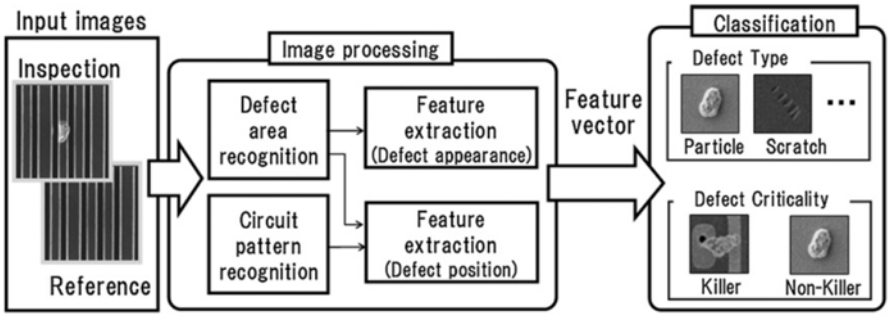

Figure 12. ADC process flow (reproduced from [30], with the permission of IOP Publishing).

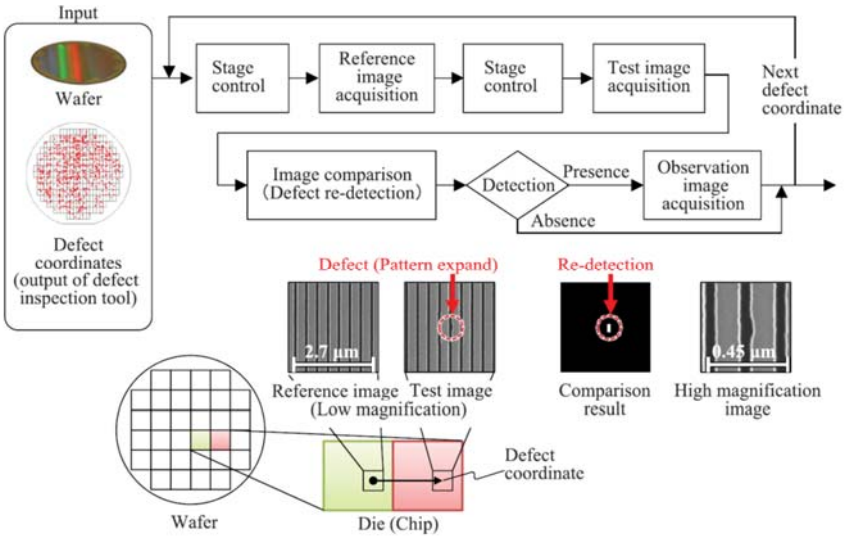

Figure 13 Process flow from optical wafer inspection tools to the ADC (reproduced from [30], with the permission of IOP Publishing).