

Energy table for EDS analysis

Hydrogen 1 H 1.01 0.08																		Helium 2 He 4.00 0.19
Lithium 3 Li 6.94 0.53	Beryllium 4 Be 9.01 1.85 Kα 0.110																	
Sodium 11 Na 22.99 0.97 Kα 1.041	Magnesium 12 Mg 24.31 1.74 Kα 1.253																	
Potassium 19 K 39.10 0.87 Kα 3.312		Calcium 20 Ca 40.08 1.55 Kα 3.690	Scandium 21 Sc 44.96 2.99 Kα 4.088 Lα 0.395	Titanium 22 Ti 47.90 4.5 Kα 4.508 Lα 0.452	Vanadium 23 V 50.94 5.87 Kα 4.949 Lα 0.511	Chromium 24 Cr 52.00 7.14 Kα 5.411 Lα 0.573	Manganese 25 Mn 54.94 7.3 Kα 5.894 Lα 0.637	Iron 26 Fe 55.85 7.86 Kα 6.398 Lα 0.705	Cobalt 27 Co 58.93 8.71 Kα 6.924 Lα 0.776	Nickel 28 Ni 58.70 8.8 Kα 7.471 Lα 0.851	Copper 29 Cu 63.55 8.93 Kα 8.040 Lα 0.930	Zinc 30 Zn 65.38 6.92 Kα 8.630 Lα 1.012	Gallium 31 Ga 69.72 5.93 Kα 9.241 Lα 1.098	Germanium 32 Ge 72.59 5.46 Kα 9.874 Lα 1.188	Arsenic 33 As 74.92 5.73 Kα 10.530 Lα 1.282	Selenium 34 Se 78.96 4.82 Kα 11.207 Lα 1.379	Bromine 35 Br 79.90 4.2 Kα 11.907 Lα 1.480	Krypton 36 Kr 83.80 3.4 Kα 12.631 Lα 1.586
Rubidium 37 Rb 85.47 1.53 Kα 13.373 Lα 1.694	Strontium 38 Sr 87.62 2.66 Kα 14.140 Lα 1.806	Yttrium 39 Y 88.91 4.48 Kα 14.931 Lα 1.922	Zirconium 40 Zr 91.22 6.44 Kα 15.744 Lα 2.042	Niobium 41 Nb 92.91 8.4 Kα 16.581 Lα 2.166	Molybdenum 42 Mo 95.94 9.61 Kα 17.441 Lα 2.293	Technetium 43 Tc (97) 101.07 12.1 Kα 18.325 Lα 2.424	Ruthenium 44 Ru 101.07 12.1 Kα 19.233 Lα 2.558	Rhodium 45 Rh 102.91 12.44 Lα 2.696	Palladium 46 Pd 106.4 12.16 Lα 2.838	Silver 47 Ag 107.87 10.49 Lα 2.984	Cadmium 48 Cd 112.40 8.65 Lα 3.133	Indium 49 In 114.82 7.28 Lα 3.286 M 0.368	Tin 50 Sn 118.69 7.30 Lα 3.443 M 0.691	Antimony 51 Sb 121.75 6.62 Lα 3.604 M 0.733	Tellurium 52 Te 127.60 6.25 Lα 3.769 M 0.778	Iodine 53 I 126.90 4.94 Lα 3.937	Xenon 54 Xe 131.30 3.4 Lα 4.109	
Cesium 55 Cs 132.91 1.87 Lα 4.286	Barium 56 Ba 137.34 3.5 Lα 4.465 M 0.972	Lanthanoid 57-71	Hafnium 72 Hf 178.49 13.3 Lα 7.898 M 1.644	Tantalum 73 Ta 180.95 16.6 Lα 8.145 M 1.709	Tungsten 74 W 183.85 19.3 Lα 8.396 M 1.774	Rhenium 75 Re 186.21 20.53 Lα 8.651 M 1.842	Osmium 76 Os 190.2 22.5 Lα 8.910 M 1.914	Iridium 77 Ir 192.22 22.42 Lα 9.174 M 1.977	Platinum 78 Pt 195.09 21.37 Lα 9.441 M 2.048	Gold 79 Au 196.97 18.88 Lα 9.712 M 2.120	Mercury 80 Hg 200.59 14.19 Lα 9.987 M 2.195	Thallium 81 Tl 204.37 11.86 Lα 10.267 M 2.267	Lead 82 Pb 207.2 11.34 Lα 10.550 M 2.342	Bismuth 83 Bi 208.98 9.78 Lα 10.837 M 2.419	Polonium 84 Po (209) Lα 11.129	Astatine 85 At (210) Lα 11.425	Radon 86 Rn (222) Lα 11.725	
Francium 87 Fr (223) Lα 12.029	Radium 88 Ra 226.03 5 Lα 12.340	Actinoid 89-103	Lanthanum 57 La 138.91 6.17 Lα 4.650 M 0.833	Cerium 58 Ce 140.12 6.66 Lα 4.839 M 0.883	Praseodymium 59 Pr 140.91 6.77 Lα 5.033 M 0.929	Neodymium 60 Nd 144.24 7.02 Lα 5.229 M 0.978	Promethium 61 Pm (145) Lα 5.432	Samarium 62 Sm 150.4 7.54 Lα 5.635 M 1.081	Europium 63 Eu 151.96 5.25 Lα 5.845 M 1.131	Gadolinium 64 Gd 157.25 7.90 Lα 6.056 M 1.185	Terbium 65 Tb 158.93 8.25 Lα 6.272 M 1.240	Dysprosium 66 Dy 162.50 8.56 Lα 6.494 M 1.293	Holmium 67 Ho 164.93 8.80 Lα 6.719 M 1.347	Erbium 68 Er 167.26 9.06 Lα 6.947 M 1.405	Thulium 69 Tm 168.93 9.32 Lα 7.179 M 1.462	Ytterbium 70 Yb 173.04 6.96 Lα 7.414 M 1.521	Lutetium 71 Lu 174.97 9.84 Lα 7.654 M 1.581	
			Actinium 89 Ac (227) 10.87 Lα 12.650	Thorium 90 Th 232.04 11.00 Lα 12.967 M 2.991	Protactinium 91 Pa 231.04 Lα 13.288 M 3.077	Uranium 92 U 238.03 18.7 Lα 13.612 M 3.164	Neptunium 93 Np 237.05 Lα 13.942 M 3.260	Plutonium 94 Pu (244) Lα 14.276 M 3.348	Americium 95 Am (243) Lα 14.615 M 3.437	Curium 96 Cm (247) Lα 14.953 M 3.539	Berkelium 97 Bk (247) Lα 15.304 M 3.634	Californium 98 Cf (251) Lα 15.652 M 3.731	Einsteinium 99 Es (254) Lα 15.999 M 3.826	Fermium 100 Fm (257) Lα 16.346 M 3.921	Mendelevium 101 Md (258) Lα 16.693 M 4.016	Nobelium 102 No (259) Lα 17.040 M 4.111	Lawrencium 103 Lr (262) Lα 17.387 M 4.206	

Number

Atomic mass

Gold

79 Au

Name

Symbol

Incident Electron

Secondary Electron

Characteristic X-rays

Electron

K shell

L shell

M shell

N shell

O shell

Nucleus

Electron transmissions of major lines

N IV

N III

N II

M V

M IV

M III

M II

M I

L III

L II

L I

K I

α₁

α₂

β₁

β₂

γ₁

γ₂

γ₃

γ₄

γ₅

γ₆

γ₇

γ₈

γ₉

γ₁₀

γ₁₁

γ₁₂

γ₁₃

γ₁₄

γ₁₅

γ₁₆

γ₁₇

γ₁₈

γ₁₉

γ₂₀

γ₂₁

γ₂₂

γ₂₃

γ₂₄

γ₂₅

γ₂₆

γ₂₇

γ₂₈

γ₂₉

γ₃₀

γ₃₁

γ₃₂

γ₃₃

γ₃₄

γ₃₅

γ₃₆

γ₃₇

γ₃₈

γ₃₉

γ₄₀

γ₄₁

γ₄₂

γ₄₃

γ₄₄

γ₄₅

γ₄₆

γ₄₇

γ₄₈

γ₄₉

γ₅₀

γ₅₁

γ₅₂

γ₅₃

γ₅₄

γ₅₅

γ₅₆

γ₅₇

γ₅₈

γ₅₉

γ₆₀

γ₆₁

γ₆₂

γ₆₃

γ₆₄

γ₆₅

γ₆₆

γ₆₇

γ₆₈

γ₆₉

γ₇₀

γ₇₁

γ₇₂

γ₇₃

γ₇₄

γ₇₅

γ₇₆

γ₇₇

γ₇₈

γ₇₉

γ₈₀

γ₈₁

γ₈₂

γ₈₃

γ₈₄

γ₈₅

γ₈₆

γ₈₇

γ₈₈

γ₈₉

γ₉₀

γ₉₁

γ₉₂

γ₉₃

γ₉₄

γ₉₅

γ₉₆

γ₉₇

γ₉₈

γ₉₉

γ₁₀₀

γ₁₀₁

γ₁₀₂

γ₁₀₃

γ₁₀₄

γ₁₀₅

γ₁₀₆

γ₁₀₇

γ₁₀₈

γ₁₀₉

γ₁₁₀

γ₁₁₁

γ₁₁₂

γ₁₁₃

γ₁₁₄

γ₁₁₅

γ₁₁₆

γ₁₁₇

γ₁₁₈

γ₁₁₉

γ₁₂₀

γ₁₂₁

γ₁₂₂

γ₁₂₃

γ₁₂₄

γ₁₂₅

γ₁₂₆

γ₁₂₇

γ₁₂₈

γ₁₂₉

γ₁₃₀

γ₁₃₁

γ₁₃₂

γ₁₃₃

γ₁₃₄

γ₁₃₅

γ₁₃₆

γ₁₃₇

γ₁₃₈

γ₁₃₉

γ₁₄₀

γ₁₄₁

γ₁₄₂

γ₁₄₃

γ₁₄₄

γ₁₄₅

γ₁₄₆

γ₁₄₇

γ₁₄₈

γ₁₄₉

γ₁₅₀

γ₁₅₁

γ₁₅₂

γ₁₅₃

γ₁₅₄

γ₁₅₅

γ₁₅₆

γ₁₅₇

γ₁₅₈

γ₁₅₉

γ₁₆₀

γ₁₆₁

γ₁₆₂

γ₁₆₃

γ₁₆₄

γ₁₆₅

γ₁₆₆

γ₁₆₇

γ₁₆₈

γ₁₆₉

γ₁₇₀

γ₁₇₁

γ₁₇₂

γ₁₇₃

γ₁₇₄

γ₁₇₅

γ₁₇₆

γ₁₇₇

γ₁₇₈

γ₁₇₉

γ₁₈₀

γ₁₈₁

γ₁₈₂

γ₁₈₃

γ₁₈₄

γ₁₈₅

γ₁₈₆

γ₁₈₇

γ₁₈₈

γ₁₈₉

γ₁₉₀

γ₁₉₁

γ₁₉₂

γ₁₉₃

γ₁₉₄

γ₁₉₅

γ₁₉₆

γ₁₉₇

γ₁₉₈

γ₁₉₉

γ₂₀₀

γ₂₀₁

γ₂₀₂

γ₂₀₃

γ₂₀₄

γ₂₀₅

γ₂₀₆

γ₂₀₇

γ₂₀₈

γ₂₀₉

γ₂₁₀

γ₂₁₁

γ₂₁₂

γ₂₁₃

γ₂₁₄

γ₂₁₅

γ₂₁₆

γ₂₁₇

γ₂₁₈

γ₂₁₉

γ₂₂₀

γ₂₂₁

γ₂₂₂

γ₂₂₃

γ₂₂₄

γ₂₂₅

γ₂₂₆

γ₂₂₇

γ₂₂₈

γ₂₂₉

γ₂₃₀

γ₂₃₁

γ₂₃₂

γ₂₃₃

γ₂₃₄

γ₂₃₅

γ₂₃₆

γ₂₃₇

γ₂₃₈

γ₂₃₉

γ₂₄₀

γ₂₄₁

γ₂₄₂

γ₂₄₃

γ₂₄₄

γ₂₄₅

γ₂₄₆

γ₂₄₇

γ₂₄₈

γ₂₄₉

γ₂₅₀

γ₂₅₁

γ₂₅₂

γ₂₅₃

γ₂₅₄

γ₂₅₅

γ₂₅₆

γ₂₅₇

γ₂₅₈

γ₂₅₉

γ₂₆₀

γ₂₆₁

γ₂₆₂

γ₂₆₃

γ₂₆₄

γ₂₆₅

γ₂₆₆

γ₂₆₇

γ₂₆₈

γ₂₆₉

γ₂₇₀

γ₂₇₁

γ₂₇₂

γ₂₇₃

γ₂₇₄

γ₂₇₅

γ₂₇₆

γ₂₇₇

γ₂₇₈

γ₂₇₉

γ₂₈₀

γ₂₈₁

γ₂₈₂

γ₂₈₃

γ₂₈₄

γ₂₈₅

γ₂₈₆

γ₂₈₇

γ₂₈₈

γ₂₈₉

γ₂₉₀

γ₂₉₁

γ₂₉₂

γ₂₉₃

γ₂₉₄

γ₂₉₅

γ₂₉₆

γ₂₉₇

γ₂₉₈

γ₂₉₉

γ₃₀₀

γ₃₀₁

γ₃₀₂

γ₃₀₃

γ₃₀₄

γ₃₀₅

γ₃₀₆

γ₃₀₇

γ₃₀₈

γ₃₀₉

γ₃₁₀

γ₃₁₁

γ₃₁₂

γ₃₁₃

γ₃₁₄

γ₃₁₅

γ₃₁₆

γ₃₁₇

γ₃₁₈

γ₃₁₉

γ₃₂₀

γ₃₂₁

γ₃₂₂

γ₃₂₃

γ₃₂₄

γ₃₂₅

γ₃₂₆

γ₃₂₇

γ₃₂₈

γ₃₂₉

γ₃₃₀

γ₃₃₁

γ₃₃₂

γ₃₃₃

γ₃₃₄

γ₃₃₅

γ₃₃₆

γ₃₃₇

γ₃₃₈

γ₃₃₉

γ₃₄₀

γ₃₄₁

γ₃₄₂

γ₃₄₃

γ₃₄₄

γ₃₄₅

γ₃₄₆

γ₃₄₇

γ₃₄₈

γ₃₄₉

γ₃₅₀

γ₃₅₁

γ₃₅₂

γ₃₅₃

γ₃₅₄

γ₃₅₅

γ₃₅₆

γ₃₅₇

γ₃₅₈

γ₃₅₉

γ₃₆₀

γ₃₆₁

γ₃₆₂

γ₃₆₃

γ₃₆₄

γ₃₆₅

γ₃₆₆

γ₃₆₇

γ₃₆₈

γ₃₆₉

γ₃₇₀

γ₃₇₁

γ₃₇₂

γ₃₇₃

γ₃₇₄

γ₃₇₅

γ₃₇₆

γ₃₇₇

γ₃₇₈

γ₃₇₉

γ₃₈₀

γ₃₈₁

γ₃₈₂

γ₃₈₃

γ₃₈₄

γ₃₈₅

γ₃₈₆

γ₃₈₇

γ₃₈₈

γ₃₈₉

γ₃₉₀

γ₃₉₁

γ₃₉₂

γ₃₉₃

γ₃₉₄

γ₃₉₅

γ₃₉₆

γ₃₉₇

γ₃₉₈

γ₃₉₉

γ₄₀₀

γ₄₀₁

γ₄₀₂

γ₄₀₃

γ₄₀₄

γ₄₀₅

γ₄₀₆

γ₄₀₇

γ₄₀₈

γ₄₀₉

γ₄₁₀

γ₄₁₁

γ₄₁₂

γ₄₁₃

γ₄₁₄

γ₄₁₅

γ₄₁₆

γ₄₁₇

γ₄₁₈

γ₄₁₉

γ₄₂₀

γ₄₂₁

γ₄₂₂

γ₄₂₃

γ₄₂₄

γ₄₂₅

γ₄₂₆

γ₄₂₇

γ₄₂₈

γ₄₂₉

γ₄₃₀

γ₄₃₁

γ₄₃₂

γ₄₃₃

γ₄₃₄

γ₄₃₅

γ₄₃₆

γ₄₃₇

γ₄₃₈

γ₄₃₉

γ₄₄₀

γ₄₄₁

γ₄₄₂

γ₄₄₃

γ₄₄₄

γ₄₄₅

γ₄₄₆

γ₄₄₇

γ₄₄₈

γ₄₄₉

γ₄₅₀

γ₄₅₁

γ₄₅₂

γ₄₅₃

γ₄₅₄

γ₄₅₅

γ₄₅₆

γ₄₅₇

γ₄₅₈

γ₄₅₉

γ₄₆₀

γ₄₆₁

γ₄₆₂

γ₄₆₃

γ₄₆₄

γ₄₆₅

γ₄₆₆

γ₄₆₇

γ₄₆₈

γ₄₆₉

γ₄₇₀

γ₄₇₁

γ₄₇₂

γ₄₇₃

γ₄₇₄

γ₄₇₅

γ₄₇₆

γ₄₇₇

γ₄₇₈

γ₄₇₉

γ₄₈₀

γ₄₈₁

γ₄₈₂

γ₄₈₃

γ₄₈₄

γ₄₈₅

γ₄₈₆

γ₄₈₇

γ₄₈₈

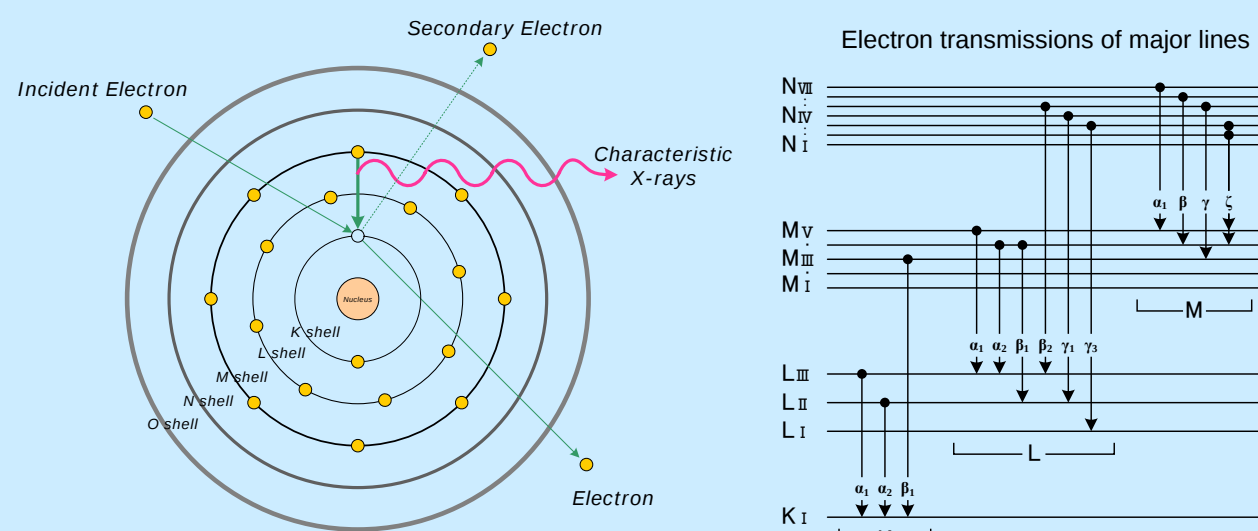
γ₄₈₉

γ₄₉₀

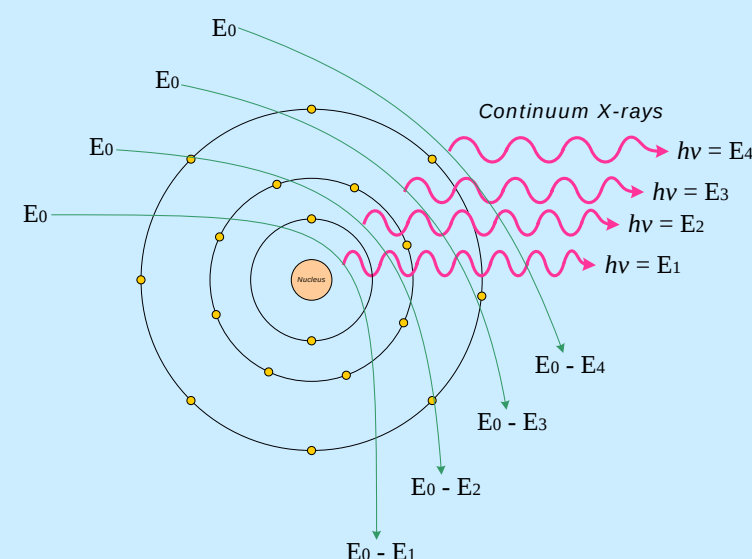
γ₄₉₁

γ_{492</}

Characteristic X-rays



Continuum X-rays



The electrons generated by the electron gun are accelerated and irradiate the sample. The electron has a kinetic energy proportional to the accelerating voltage. The kinetic energy dissipated within the sample generates characteristic signals from the specimen. The characteristic X-rays are the information used for EDS analysis.

If the incident electrons have sufficient acceleration and then have enough energy to strike an electron from the inner shell of the atom, it'll make an electron hole. An electron from the outer shell will fill up the hole and then, some characteristic X-rays will be emitted. The characteristic X-rays have different energy for each element, and the intensity will be proportional to the element concentration.

The continuum X-rays are emitted when the primary electrons are decelerated by the strong electric field existing close to atomic nucleus. The continuum X-rays have the energy of the kinetic energy lost during the deceleration. It will be observed as EDS spectrum background.

Number: 79, Atomic mass: 196.97, Density (kg/m³): 19.3, Name: Gold, Symbol: Au, Characteristic X-ray (keV): 2.120

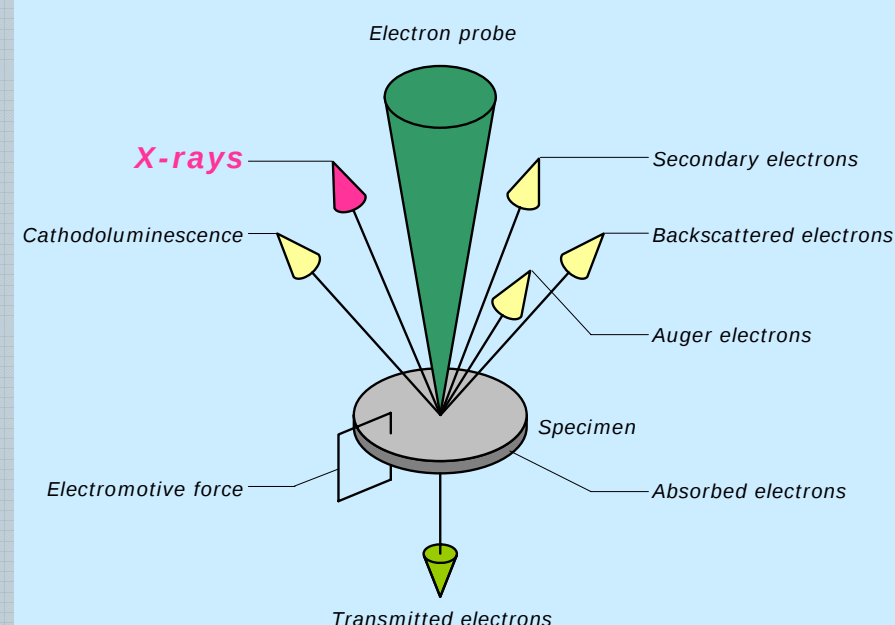
Note: Density
* 'C' as (graphite), 'P' as (white),
'S' as (alpha), 'Sn' as (white)

Minimum accelerating voltage

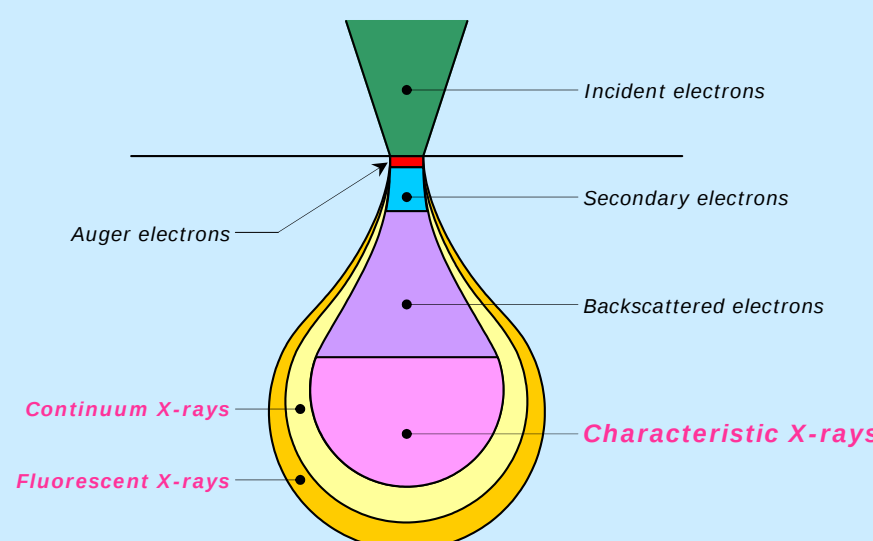
Unable to detect	5kV or higher
10kV or higher	15kV or higher

The colors mean to detect the characteristic X-ray of the lowest energy for each element.

Information from specimen



Generation depth and space resolution

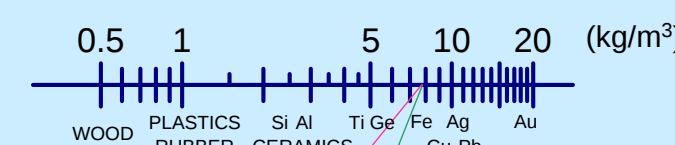
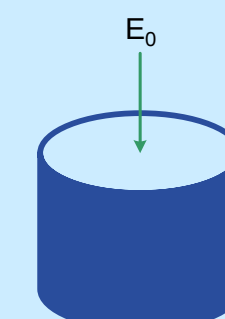


Analytical area

Castaing's formula

$$Z_m = 0.033 (E_0^{1.7} - E_C^{1.7}) \frac{A}{\rho Z}$$

E_0 : Accelerating voltage (kV)
 E_C : Minimum emission voltage (keV)
 A : Atomic mass
 ρ : Density (kg/m³)
 Z : Atomic number



Analytical area of iron in 20kV $\approx 1.5 - 0.2 = 1.3 (\mu m)$