

Hydrogen
1 H
1.01
0.08

Lithium
3 Li
6.94
0.53

Beryllium
4 Be
9.01
1.85
K α 0.110

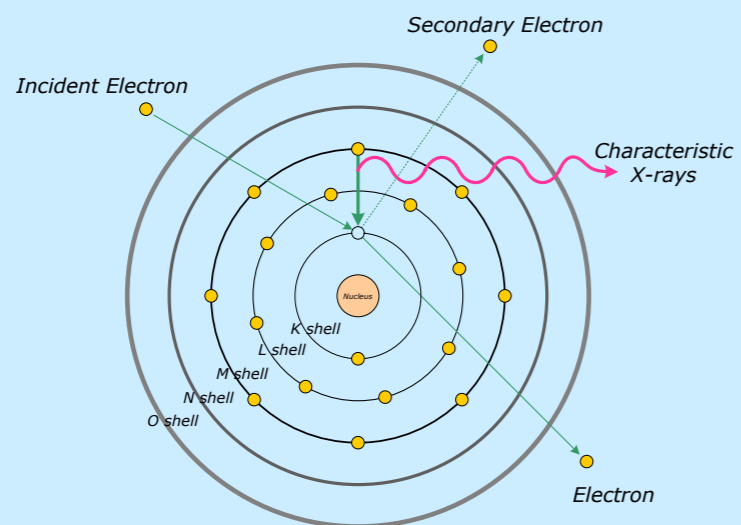
Sodium
11 Na
22.99
0.97
K α 1.041

Magnesium
12 Mg
24.31
1.74
K α 1.253

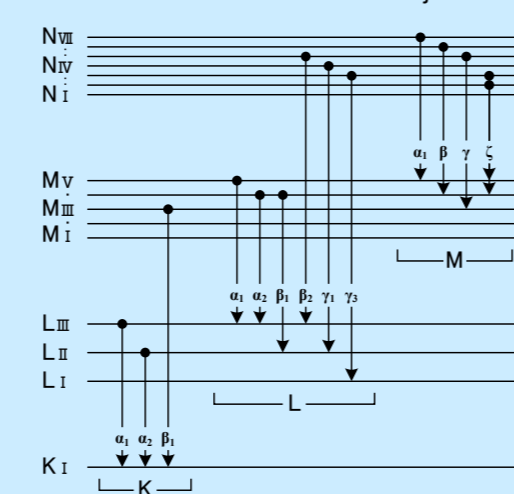
Potassium
19 K
39.10
0.87
K α 3.312

Calcium
20 Ca
40.08
1.55
K α 3.690

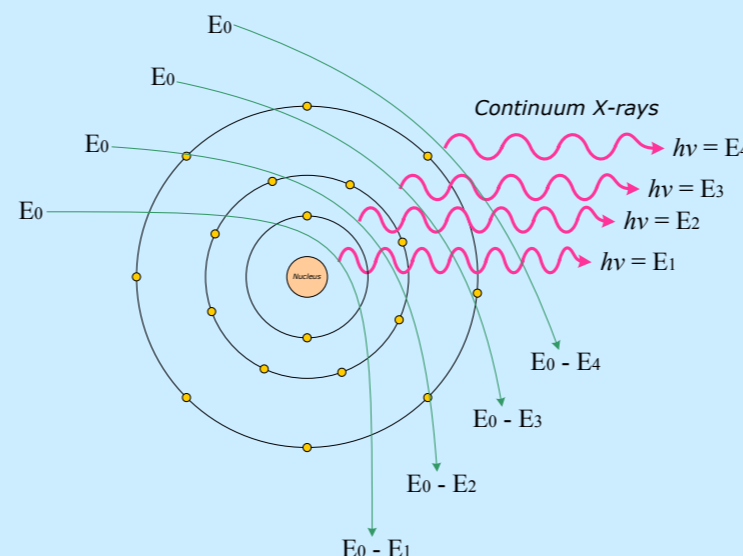
Characteristic X-rays



Electron transmissions of major lines



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.

Helium
2 He
4.00
0.19

Boron
5 B
10.81
2.54
K α 0.183

Carbon
6 C
12.01
2.25 *
K α 0.277

Nitrogen
7 N
14.01
1.14
K α 0.392

Oxygen
8 O
16.00
1.57
K α 0.525

Fluorine
9 F
19.00
1.5
K α 0.677

Neon
10 Ne
20.18
1.20
K α 0.848

Aluminium
13 Al
26.98
2.70
K α 1.486

Silicon
14 Si
28.09
2.42
K α 1.739

Phosphorus
15 P
30.97
2.97
K α 2.013

Sulphur
16 S
32.06
2.07 *
K α 2.307

Chlorine
17 Cl
35.45
2.2
K α 2.621

Argon
18 Ar
39.95
1.65
K α 2.957

Potassium
19 K
39.10
0.87
K α 3.312

Scandium
21 Sc
44.96
2.99
K α 4.088
L α 0.395

Titanium
22 Ti
47.90
4.5
K α 4.508
L α 0.452

Vanadium
23 V
50.94
5.87
K α 4.949
L α 0.511

Chromium
24 Cr
52.00
7.14
K α 5.411
L α 0.573

Manganese
25 Mn
54.94
7.3
K α 5.894
L α 0.637

Iron
26 Fe
55.85
7.86
K α 6.398
L α 0.705

Cobalt
27 Co
58.93
8.71
K α 6.924
L α 0.776

Nickel
28 Ni
58.70
8.8
K α 7.471
L α 0.851

Copper
29 Cu
63.55
8.93
K α 8.040
L α 0.930

Zinc
30 Zn
65.38
6.92
K α 8.630
L α 1.012

Gallium
31 Ga
69.72
5.93
K α 9.241
L α 1.098

Germanium
32 Ge
72.59
5.46
K α 9.874
L α 1.188

Arsenic
33 As
74.92
5.73
K α 10.530
L α 1.282

Selenium
34 Se
78.96
4.82
K α 11.207
L α 1.379

Bromine
35 Br
79.90
4.2
K α 11.907
L α 1.480

Krypton
36 Kr
83.80
3.4
K α 12.631
L α 1.586

Rubidium
37 Rb
85.47
1.53
K α 13.373
L α 1.694

Strontium
38 Sr
87.62
2.60
K α 14.140
L α 1.806

Yttrium
39 Y
88.91
4.48
K α 14.931
L α 1.922

Zirconium
40 Zr
91.22
6.44
K α 15.744
L α 2.042

Niobium
41 Nb
92.91
8.4
K α 16.581
L α 2.166

Molybdenum
42 Mo
95.94
9.01
K α 17.441
L α 2.293

Technetium
43 Tc
(97)
101.07
12.1
K α 18.325
L α 2.424

Ruthenium
44 Ru
101.07
12.1
K α 19.233
L α 2.558

Rhodium
45 Rh
102.91
12.44
K α 2.696

Palladium
46 Pd
106.4
12.16
K α 2.838

Silver
47 Ag
107.87
10.49
K α 2.984

Cadmium
48 Cd
112.40
8.65
K α 3.133

Indium
49 In
114.82
7.28
K α 3.286
M 0.368

Tin
50 Sn
118.69
7.30 *
K α 3.443
M 0.691

Antimony
51 Sb
121.75
6.62
K α 3.604
M 0.733

Tellurium
52 Te
127.60
6.25
K α 3.769
M 0.778

Iodine
53 I
126.90
4.94
K α 3.937

Xenon
54 Xe
131.30
3.4
K α 4.109

Cesium
55 Cs
132.91
1.87
L α 4.286

Barium
56 Ba
137.34
3.5
L α 4.465
M 0.972

Lanthanoid
57-71

Hafnium
72 Hf
178.49
13.3
L α 7.898
M 1.644

Tantalum
73 Ta
180.95
16.6
L α 8.145
M 1.709

Tungsten
74 W
183.85
19.3
L α 8.396
M 1.774

Rhenium
75 Re
186.21
20.53
L α 8.651
M 1.842

Osmium
76 Os
190.2
22.5
L α 8.910
M 1.914

Iridium
77 Ir
192.22
22.42
L α 9.174
M 1.977

Platinum
78 Pt
195.09
21.37
L α 9.441
M 2.048

Gold
79 Au
196.97
18.88
L α 9.712
M 2.120

Mercury
80 Hg
200.59
14.19
L α 9.987
M 2.195

Thallium
81 Tl
204.37
11.86
L α 10.267
M 2.267

Lead
82 Pb
207.2
11.34
L α 10.550
M 2.342

Bismuth
83 Bi
208.98
9.78
L α 10.837
M 2.419

Polonium
84 Po
(209)

Astatine
85 At
(210)

Radon
86 Rn
(222)

Francium
87 Fr
(223)

Radium
88 Ra
226.03
5
L α 12.340

Actinoid
89-103

Lanthanum
57 La
138.91
6.17
L α 4.650
M 0.833

Cerium
58 Ce
140.12
6.66
L α 4.839
M 0.883

Praseodymium
59 Pr
140.91
6.77
L α 5.033
M 0.929

Neodymium
60 Nd
144.24
7.02
L α 5.229
M 0.978

Promethium
61 Pm
(145)

Samarium
62 Sm
150.4
7.54
L α 5.635
M 1.081

Europium
63 Eu
151.96
5.25
L α 5.845
M 1.131

Gadolinium
64 Gd
157.25
7.90
L α 6.056
M 1.185

Terbium
65 Tb
158.93
8.25
L α 6.272
M 1.240

Dysprosium
66 Dy
162.50
8.56
L α 6.494
M 1.293

Holmium
67 Ho
164.93
8.80
L α 6.719
M 1.347

Erbium
68 Er
167.26
9.06
L α 6.947
M 1.405

Thulium
69 Tm
168.93
9.32
L α 7.179
M 1.462

Ytterbium
70 Yb
173.04
6.96
L α 7.414
M 1.521

Lutetium
71 Lu
174.97
9.84
L α 7.654
M 1.581

Gold
79 Au
196.97
18.88
L α 9.712
M 2.120
Characteristic X-ray (keV)

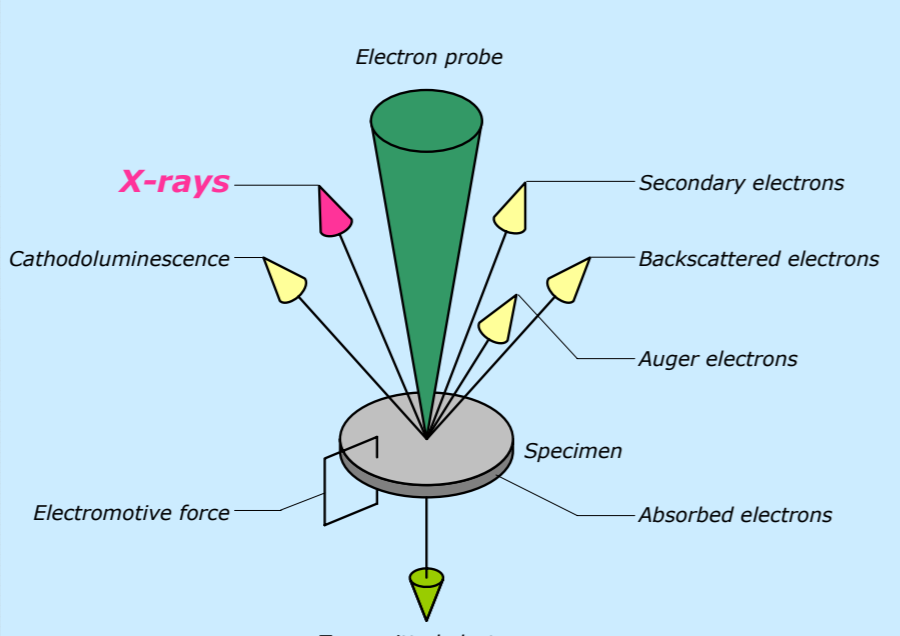
Note: Density
* 'C' as (graphite), 'P' as (white),
'S' as (alpha), 'Sn' as (white)

Minimum accelerating voltage

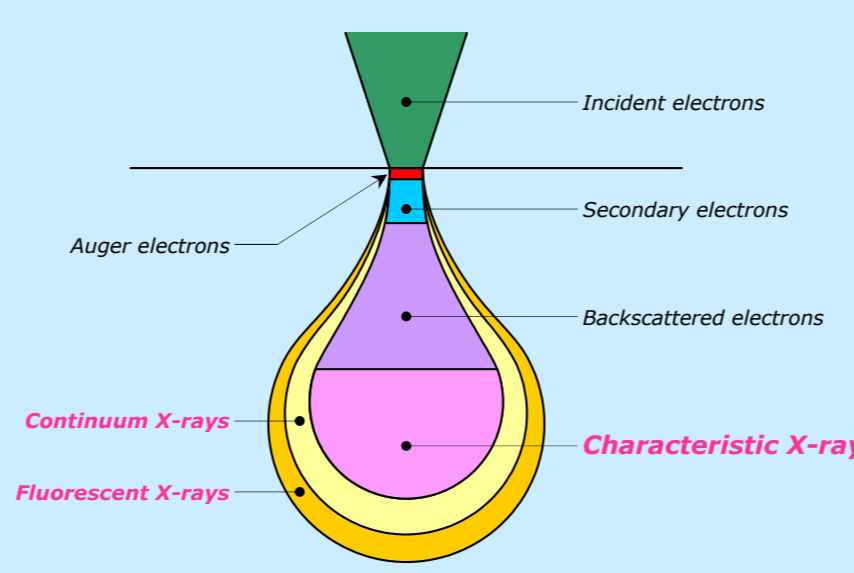
Unable to detect | 5kV or higher | 10kV or higher | 15kV or higher

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

