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Energy table for EDS analysis

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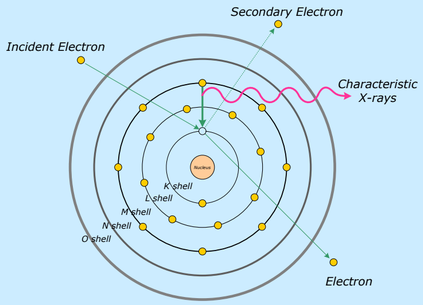
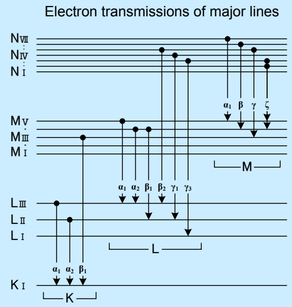
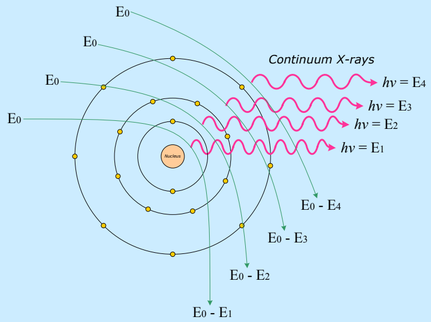
Characteristic X-rays





Continuum X-rays

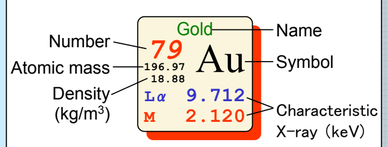


The electrons generated by the electron gun are accelerated and irradiate the sample. The electron has a kinetic energy proportional to the accelerating voltage. The kinetic energy dissipated within the sample generates characteristic signals from the specimen. The characteristic X-rays are the information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

Atomic number	Element	Atomic mass	Density (kg/m³)	Kα	Lα	Mα
1	Hydrogen H	1.01	0.08			
2	Helium He	4.00	0.19			
3	Lithium Li	6.94	0.53			
4	Beryllium Be	9.01	1.85	0.110		
5	Boron B	10.81	2.54	0.183		
6	Carbon C	12.01	2.25 *	0.277		
7	Nitrogen N	14.01	1.14	0.392		
8	Oxygen O	16.00	1.57	0.525		
9	Fluorine F	19.00	1.5	0.677		
10	Neon Ne	20.18	1.20	0.848		
11	Sodium Na	22.99	0.97	1.041		
12	Magnesium Mg	24.31	1.74	1.253		
13	Aluminium Al	26.98	2.70	1.486		
14	Silicon Si	28.09	2.42	1.739		
15	Phosphorus P	30.97	1.83 *	2.013		
16	Sulphur S	32.06	2.07 *	2.307		
17	Chlorine Cl	35.45	2.2	2.621		
18	Argon Ar	39.95	1.65	2.957		
19	Potassium K	39.10	0.87	3.312		
20	Calcium Ca	40.08	1.55	3.690		
21	Scandium Sc	44.96	2.99	4.088	0.395	
22	Titanium Ti	47.90	4.5	4.508	0.452	
23	Vanadium V	50.94	5.87	4.949	0.511	
24	Chromium Cr	52.00	7.14	5.411	0.573	
25	Manganese Mn	54.94	7.3	5.894	0.637	
26	Iron Fe	55.85	7.86	6.398	0.705	
27	Cobalt Co	58.93	8.71	6.924	0.776	
28	Nickel Ni	58.70	8.8	7.471	0.851	
29	Copper Cu	63.55	8.93	8.040	0.930	
30	Zinc Zn	65.38	6.92	8.630	1.012	
31	Gallium Ga	69.72	5.93	9.241	1.098	
32	Germanium Ge	72.59	5.46	9.874	1.188	
33	Arsenic As	74.92	5.73	10.530	1.282	
34	Selenium Se	78.96	4.82	11.207	1.379	
35	Bromine Br	79.90	4.2	11.907	1.480	
36	Krypton Kr	83.80	3.4	12.631	1.586	
37	Rubidium Rb	85.47	1.53	13.373	1.694	
38	Strontium Sr	87.62	2.60	14.140	1.806	
39	Yttrium Y	88.91	4.48	14.931	1.922	
40	Zirconium Zr	91.22	6.44	15.744	2.042	
41	Niobium Nb	92.91	8.4	16.581	2.166	
42	Molybdenum Mo	95.94	9.01	17.441	2.293	
43	Technetium Tc	(97)		18.325	2.424	
44	Ruthenium Ru	101.07	12.1	19.233	2.558	
45	Rhodium Rh	102.91	12.44	2.696		
46	Palladium Pd	106.4	12.16	2.838		
47	Silver Ag	107.87	10.49	2.984		
48	Cadmium Cd	112.40	8.65	3.133		
49	Indium In	114.82	7.28	3.286	0.368	
50	Tin Sn	118.69	7.30 *	3.443	0.691	
51	Antimony Sb	121.75	6.62	3.604	0.733	
52	Tellurium Te	127.60	6.25	3.769	0.778	
53	Iodine I	126.90	4.94	3.937		
54	Xenon Xe	131.30	3.4	4.109		
55	Cesium Cs	132.91	1.87	4.286		
56	Barium Ba	137.34	3.5	4.465	0.972	
57–71	Lanthanoid					
72	Hafnium Hf	178.49	13.3	7.898	1.644	
73	Tantalum Ta	180.95	16.6	8.145	1.709	
74	Tungsten W	183.85	19.3	8.396	1.774	
75	Rhenium Re	186.21	20.53	8.651	1.842	
76	Osmium Os	190.2	22.5	8.910	1.914	
77	Iridium Ir	192.22	22.42	9.174	1.977	
78	Platinum Pt	195.09	21.37	9.441	2.048	
79	Gold Au	196.97	18.88	9.712	2.120	
80	Mercury Hg	200.59	14.19	9.987	2.195	
81	Thallium Tl	204.37	11.86	10.267	2.267	
82	Lead Pb	207.2	11.34	10.550	2.342	
83	Bismuth Bi	208.98	9.78	10.837	2.419	
84	Polonium Po	(209)		11.129		
85	Astatine At	(210)		11.425		
86	Radon Rn	(222)		11.725		
87	Francium Fr	(223)		12.029		
88	Radium Ra	226.03 5		12.340		
89–103	Actinoid					
57	Lanthanum La	138.91	6.17	4.650	0.833	
58	Cerium Ce	140.12	6.66	4.839	0.883	
59	Praseodymium Pr	140.91	6.77	5.033	0.929	
60	Neodymium Nd	144.24	7.02	5.229	0.978	
61	Prometium Pm	(145)		5.432		
62	Samarium Sm	150.4	7.54	5.635	1.081	
63	Europium Eu	151.96	5.25	5.845	1.131	
64	Gadolinium Gd	157.25	7.90	6.056	1.185	
65	Terbium Tb	158.93	8.25	6.272	1.240	
66	Dysprosium Dy	162.50	8.56	6.494	1.293	
67	Holmium Ho	164.93	8.80	6.719	1.347	
68	Erbium Er	167.26	9.06	6.947	1.405	
69	Thulium Tm	168.93	9.32	7.179	1.462	
70	Ytterbium Yb	173.04	6.96	7.414	1.521	
71	Lutetium Lu	174.97	9.84	7.654	1.581	
89	Actinium Ac	(227)	10.07	12.650		
90	Thorium Th	232.04	11.00	12.967	2.991	
91	Protactinium Pa	231.04		13.288	3.077	
92	Uranium U	238.03	18.7	13.612	3.164	
93	Neptunium Np	237.05		13.942	3.260	
94	Plutonium Pu	(244)		14.276	3.348	
95	Americium Am	(243)		14.615	3.437	
96	Curium Cm	(247)		14.953	3.539	
97	Berkelium Bk	(247)		15.304	3.634	
98	Californium Cf	(251)		15.652	3.731	
99	Einsteinium Es	(254)				
100	Fermium Fm	(257)				
101	Mendelevium Md	(258)				
102	Nobelium No	(255)				
103	Lawrencium Lr	(262)				



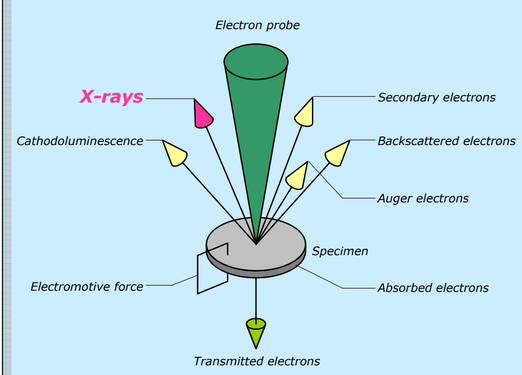
Note: Density
* 'C' as (graphite), 'P' as (white), 'S' as (alpha), 'Sn' as (white)

Minimum accelerating voltage

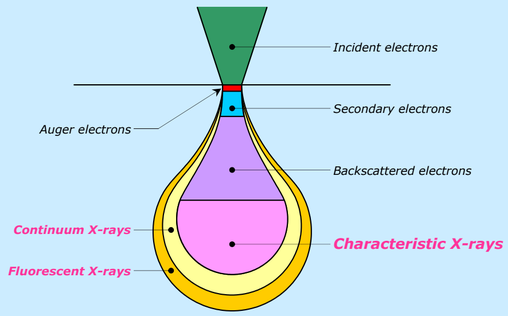
- Unable to detect
- 5kV or higher
- 10kV or higher
- 15kV or higher

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

Information from specimen



Generation depth and space resolution



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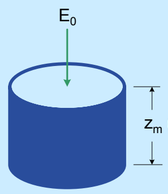
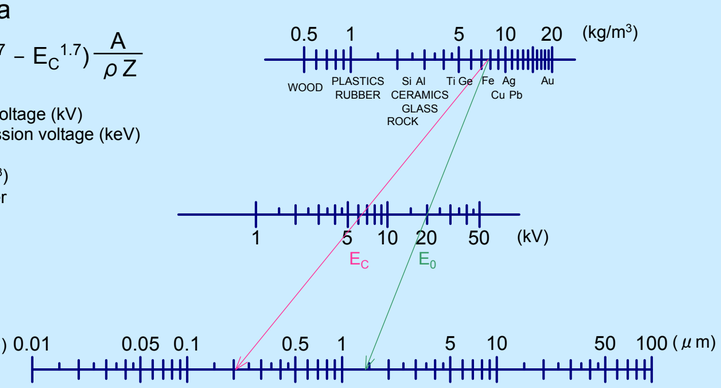
Analytical area

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 ≒ 1.5 – 0.2 = 1.3 (μm)

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