Appendix 3

Properties of pure and composite materials

[From Particle Data Group; *Phys. Lett.* **B592** (2004) 1–1109; *J. Phys.* **G33** (2006) 1–1232.]

*Properties of pure materials**

Material	Z	A	Nuclear interaction length $[g/cm^2]$	$\left.\frac{dE}{dx}\right\|_{min}$ $\left[\frac{MeV}{g/cm^2}\right]$	Radiation length $[g/cm^2]$	Density $[g/cm^3]$	Refractive index at STP†
H_2 gas	1	1.008	50.8	4.1	61.3	$0.0899 \cdot 10^{-3}$	1.000 139 2
He gas	2	4.003	65.1	1.937	94.3	$0.1786 \cdot 10^{-3}$	1.000 034 9
Be	4	9.012	75.2	1.594	65.19	1.848	
C	6	12.011	86.3	1.745	42.7	2.265	
N_2 gas	7	14.007	87.8	1.825	37.99	$1.25 \cdot 10^{-3}$	1.000 298
O_2 gas	8	15.999	91.0	1.801	34.24	$1.43 \cdot 10^{-3}$	1.000 296
Al	13	26.981	106.4	1.615	24.01	2.70	
Si	14	28.086	106.0	1.664	21.82	2.33	3.95
Ar gas	18	39.948	117.2	1.519	19.55	$1.78 \cdot 10^{-3}$	1.000 283
Fe	26	55.845	131.9	1.451	13.84	7.87	
Cu	29	63.546	134.9	1.403	12.86	8.96	
Ge	32	72.610	140.5	1.371	12.25	5.323	
Xe gas	54	131.29	169	1.255	8.48	$5.86 \cdot 10^{-3}$	1.000 701
W	74	183.84	185	1.145	6.76	19.3	
Pb	82	207.2	194	1.123	6.37	11.35	
U	92	238.03	199	1.082	6.00	18.95	

* The nuclear interaction length λ_I in g/cm^2 is related to the inelastic cross section by $\lambda_I = A/(N_A \cdot \sigma_{inel})$, where A is given in g/mol, N_A in mol^{-1}, and σ_{inel} in cm^2. There is no unequivocal name for λ_I in the literature. Frequently, λ_I is also called nuclear absorption length λ_a.

† Standard temperature and pressure ($0\,°C \mathrel{\hat{=}} 273.15\,K$ and $1\,atm = 101\,325\,Pa$). Refractive indices are evaluated at the sodium D line.

https://doi.org/10.1017/9781009401531.025 Published online by Cambridge University Press

Properties of composite materials ‡

Material	Nuclear interaction length [g/cm^2]	$\left.\frac{dE}{dx}\right\vert_{\min}$ $\left[\frac{\text{MeV}}{\text{g/cm}^2}\right]$	Radiation length [g/cm^2]	Density [g/cm^3]	Refractive index at STP
Air (STP)	90.0	1.815	36.66	$1.29 \cdot 10^{-3}$	1.000 293
H_2O	83.6	1.991	36.08	1.00	1.33
CO_2 gas	89.7	1.819	36.20	$1.977 \cdot 10^{-3}$	1.000 410
Shielding concrete	99.9	1.711	26.70	2.5	
CH_4 gas	73.4	2.417	46.22	$0.717 \cdot 10^{-3}$	1.000 444
C_2H_6 gas	75.7	2.304	45.47	$1.356 \cdot 10^{-3}$	1.001 038
C_3H_8 gas	76.5	2.262	45.20	$1.879 \cdot 10^{-3}$	1.001 029
Isobutane	77.0	2.239	45.07	$2.67 \cdot 10^{-3}$	1.001 900
Polyethylene	78.4	2.076	44.64	≈ 0.93	
Plexiglas	83.0	1.929	40.49	≈ 1.18	≈ 1.49
Polystyrene scintillator	81.9	1.936	43.72	1.032	1.581
BaF_2	145	1.303	9.91	4.89	1.56
BGO	157	1.251	7.97	7.1	2.15
CsI	167	1.243	8.39	4.53	1.80
NaI	151	1.305	9.49	3.67	1.775
Silica aerogel	96.9	1.740	27.25	0.04–0.6	$1.0 + 0.21 \cdot \varrho$
G10	90.2	1.87	33.0	1.7	
Kapton	85.8	1.82	40.56	1.42	
Pyrex Corning (borosilicate)	97.6	1.695	28.3	2.23	1.474
Lead glass (SF-5)	132.4	1.41	10.38	4.07	1.673

‡ The nuclear interaction length λ_I in g/cm^2 is related to the inelastic cross section by $\lambda_I = A/(N_A \cdot \sigma_{inel})$, where A is given in g/mol, N_A in mol^{-1}, and σ_{inel} in cm^2. There is no unequivocal name for λ_I in the literature. Frequently, λ_I is also called nuclear absorption length λ_a.

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