Chapter 2
Spectral Lines in Natural Diamond

In this chapter ca. 600 lines (and bands), which are observed in natural diamond (see Sect. 1.2.1), are presented in 32 tables. The entries are assigned to 120 centers. The corresponding defect structure is established for 18 centers, is almost certain for 20 centers, and is incomplete or unknown for 82 centers.

Chapter 2 is subdivided into *absorption lines* (Sect. 2.1: 230 **NA** lines in 11 tables (see Tables 2.1.1.1–2.1.8)), into *photoluminescence excitation (PLE) lines* (Sect. 2.2: 50 **NE** lines in three tables (see Tables 2.2.1–2.2.3)), into *luminescence lines* (Sect. 2.3: 280 **NL** lines in 15 tables (see Tables 2.3.1–2.3.11.3)), and into *broad bands* (Sect. 2.4: 40 **NB** bands in three tables (see Tables 2.4.1–2.4.3)).

The progress achieved within the last 30 years can be estimated from the following comparison. In 1979 the comprehensive review "Optical Absorption and Luminescence in Diamond" was published [Wal79]. For natural diamond 20 centers are described, but only four corresponding structures are given (A center $= N_2°$, C center $= N_1°$, boron acceptor $= B_1°$, and N3 center $= V_1N_3°$). The present knowledge is an increase of 500%.

2.1   Absorption lines (NA)

Table 2.1.1.1 Natural diamond: absorption lines, far infrared, Part 1 (0.04–0.144 eV)

Line-label	Energy (meV)	Frequ. (cm^{-1})	Wavel. (μm)	Name	Impur./defect	Comment	Figs. 3–6. [Zai01]; Fig. 7. [Zai98]	References
NA0041a′	40.91	330.0	30.30	D-cent.(a′)	*$(C_{2n})_i$°	Six IR lines a′–f′(177.3 meV), also named platelets or B′, luminescence line *D(a) at 1.528 eV, see Table 8.2.2	…	[Bok86, Jon92, Zai01]
NA0058	57.65	465.0	21.51	…	…	…	**3.7**	[Fer96, Zai01]
NA0059	59.02	476.1	21.01	…	…	Observed at $T > 450\,°C$	…	[Bie67, Zai01]
NA0060a′	60.00	484.0	20.66	A-cent.(a′)	N_2°	Five IR lines a′–e′(158.9 meV), two UV lines A(a, b) at 3.928, 4.470 eV, see Table 9.1.1.3	**3.29**, **7.31**	[Ang65, Bok86, Zai01]
NA0094a′	93.50	754.0	13.26	B-cent.(a′)	V_1N_4°	Seven IR lines a′–g′(165.1 meV); a′ var.(93.5–96.7 meV); three UV lines: *B(a1–a3) at 4.184–4.197 eV, see Table 8.2.4	**3.7**	[Fer96, Zai01]
NA0105a′	105.4	850	11.76	C-cent.(a′)	N_1°	Seven IR lines a′–g′(166.6 meV), three UV lines: *C(a, b) indirect, *C(c) at 4.059 eV, see Table 9.1.1.1	…	[Zai01]
NA0118a′	117.8	950.0	10.58	E(a′) = X(a′)	N_1^+	Seven IR lines a′–g′(165.1 meV), see Table 9.1.1.2	**3.20**	[Woo83, Law98]
NA0121a′	121.0	976.0	10.25	F-cent.(a′)	$V_1N_4(C_2)_i$°	Nine IR lines a′–i′(196.0 eV), three lines *F(a–c) at 2.145, 2.721, 4.567 eV, see Table 8.1.3.6	**3.24**; **7.26**	[Woo83, Cla84b, Dav99a]

NA0094b'	125.2	1,010	9.902	B-cent.(b')	$V_1N_4^{\circ}$	...	**3.27, 3.29,** 7.24	[Ang65, Cla84b, Law98]
NA0121b'	126.7	1,022	9.785	F-cent.(b')	$V_1N_4(C_2)_i^{\circ}$	...	**3.14, 3.20,** 7.26	[Cla84b, Col82b, Woo83]
NA0105b'	129.6	1,045	9.566	C-cent.(b')	N_1°	...	....	[Zai01]
NA0118b'	129.7	1,046	9.560	E(b') = X(b')	$*N_1^{+}$	...	**3.20, 3.30,** 7.26	[Woo83, Cla84b, Zai01]
NA0094c'	134.5	1,085	9.309	B-cent.(c')	$V_1N_4^{\circ}$	...	**3.27;** 7.24, 7.169	[Cla84b, Law98, Zai01]
NA0060b'	135.1	1,090	9.177	A-cent.(b')	N_2°	...	**3.22, 3.29;** 7.31	[Ang65, Bok86, Law93b]
NA0105c'	136.0	1,097	9.116	C-cent.(c')	N_1°	...	**3.28;** 7.24, 7.170	[Cla84b, Law93b, Zai01]
NA0118c'	138.2	1,115	8.969	E(c') = X(c')	$*N_1^{+}$	...	7.26	[Cla84b, Zai01]
NA0105d'	140.1	1,130	8.849	C-cent.(d')	N_1°	**Dominant** C-cent. line; var.(139–141 meV)	**3.28,** 7.24, 7.170	[Cla84b, Law93b, Enc94]
NA0121c'	144.1	1,162	8.604	F-cent.(c')	$V_1N_4(C_2)_i^{\circ}$	...	**3.14, 3.20,** 3.24	[Col82b, Cla84b, Woo83]

Table 2.1.1.2 Natural diamond: absorption lines, far infrared, Part 2 (0.145–0.18 eV)

Line-label	Energy (meV)	Frequ. (cm^{-1})	Wavel. (μm)	Name	Impur./defect	Comment	Figs.	References
							3-6. [Zai01]; Fig. 7. [Zai98]	
NA0094d'	145.7	1175	8.509	B-cent.(d')	$V_1N_4{}^\circ$	**Dominant** B-cent. line	3.27, 7.24, 7.169	[Cla84b, Law98, Zai98]
NA0118d'	146.9	1185	8.439	E(d') = X(d')	$*N_1{}^+$	Overlapping band	7.26	[Cla84b, Zai01]
NA0060c'	147.0	1186	8.412	A-cent.(c')	$N_2{}^\circ$	…	3.29	[Ang65]
NA0105e'	149.5	1206	8.292	C-cent.(e')	$N_1{}^\circ$	…	…	[Zai01]
NA0041b'	150.0	1210	8.265	D-cent.(b')	$*(C_{2n})_i{}^\circ$	…	3.25; 7.24	[Cla84b, Zai01]
NA0060d'	150.6	1215	8.232	A-cent.(d')	$N_2{}^\circ$	…	3.22, 3.29; 7.31	[Ang65, Cla84b, Bok86]
NA0094e'	150.6	1215	8.232	B-cent.(e')	$V_1N_4{}^\circ$	Overlapping band	3.27	[Law98]
NA0118e'	152.5	1230	8.130	E(e') = X(e')	$*N_1{}^+$	Overlapping band	7.26	[Cla84b, Zai01]
NA0121d'	154.0	1242	8.050	F-cent.(d')	$V_1N_4(C_2)_i{}^\circ$	**Dominant** F-cent. line…	3.14, 3.24; 7.26	[Col82d, Cla84b, Dav99a]
NA0041c'	156.1	1259	7.942	D-cent.(c')	$*(C_{2n})_i{}^\circ$	…	3.25; 7.24	[Cla84b, Zai01]
NA0121e'	157.5	1270	7.872	F-cent.(e')	$V_1N_4(C_2)_i{}^\circ$	…	3.14, 3.24; 7.26	[Col82d, Cla84b, Dav99a]
NA0060e'	158.9	1282	7.802	A-cent.(e')	N_2	**Dominant**, last A-cent. line, FWHM=4%	3.22, 7.24; 7.31	[Cla84b, Bok86, Law93b]
NA0094f'	158.9	1282	7.802	B-cent.(f')	$V_1N_4{}^\circ$	Overlapping band	3.27	[Law98]
NA0160	159.8	1289	7.756	……	B?	LVM of B?…	…	[Gos99, Zai01]
NA0118f'	159.9	1290	7.752	E(f') = X(f')	$*N_1{}^+$	Overlapping band	7.26	[Cla84b, Zai01]
NA0121f'	161.0	1299	7.698	F-cent.(f')	$V_1N_4(C_2)_i{}^\circ$	…	…	
NA0105f'	161.2	1300	7.692	C-cent.(f')	$N_1{}^\circ$	var. 159.9–162.4 meV…	7.24, 7.170	[Cla84b, Enc94]

NA0121g′	164.0	1323	7.559	F-cent.(g)	$V_1N_4(C_2)_i{}^\circ$	$\cdots$	**3.14** [Col82d]
NA0041d′	164.6	1328	7.532	D-cent.(d′)	$*(C_{2n})_i{}^\circ$	**Dominant,** FWHM=1%, asymm. shape	**3.25** [Cla84b, Zai01]
NA0094g′	165.1	1332	7.509	B-cent.(g′)	$V_1N_4{}^\circ$	Last B-cent. line, FWHM=0.6%	3.27, **7.24,** **7.169** [Cla84b, Law98, Zai98]
NA0118g′	165.1	1332	7.509	E(g′) = X(g′)	$*N_1{}^+$	Sharp, last E-cent. line; see Table 9.1.1.2	**7.26** [Cla84b, Zai01]
NA0105g′	166.6	1344	7.442	C-cent.(g′)	$N_1{}^\circ$	Sharp, last C-cent. line; FWHM=0.2%	**7.24,** **7.170** [Cla84b, Enc94]
NA0041d′	167.6	1352	7.396	D-cent.(d′)	$*(C_{2n})_i{}^\circ$		3.20, **3.26** [Woo83, Cla84b]
NA0041e′1	168.0	1355	7.380	D-cent.(e′1)	$*(C_{2n})_i{}^\circ$	var. 168 (large) to 172 meV (small platelets)	**3.7, 3.20,** **7.26** [Woo83, Cla84b, Fer96]
NA0041e′2	172.0	1387	7.210	D-cent.(e′2)	$*(C_{2n})_i{}^\circ$	Small platelets	3.20, **3.26** [Woo83, Cla84b]
NA0174a	174.2	1405	7.117	CH bend	$*(V_1H_1){}^\circ$	Nat. CH, two lines a, b (385.2 meV), Table 9.3.1	**3.7, 3.8,** **3.26** [Fri91a, Fer96, Rei98]
NA0041f′	177.3	1430	6.993	D-cent.(f′)	$*(C_{2n})_i{}^\circ$	Last D-cent. line, weak; see Table 8.2.2	**3.26, 7.5** [Fri91a]

Table 2.1.2.1 Natural diamond: absorption lines, mid infrared, Part 1 (0.18–0.343 eV)

Line-label	Energy (meV)	Frequ. (cm^{-1})	Wavelength (µm)	Name	Impur./defect	Comment	Figs. **3–6.** [Zai01]; Fig. **7.** [Zai98]	References
NA0182a	182.2	1470	6.803	NH bend	*$(V_1N_1H_1)$	Nat. NH, two lines a, b (401.2 meV), Table 9.3.1	3.13	[Che94b]
NA0121h	191.4	1544	6.477	F-cent.(h′)	*$V_1N_4(C_2)_i$°	…	**3.14**	[Col82b]
NA0192a	191.8	1547	6.464	NH bend	*$(V_1N_4H_1)$°	Nat. NH, two lines a, b (423.8 meV), Table 9.3.1	3.7, **3.14,** 3.26	[Col82b, Fri91a, Fer96]
NA0121i	195.9	1580	6.329	F-cent.(i′)	*$V_1N_4(C_2)_i$°	Last F-cent. line	**3.14**	[Col82b]
NA0225a	225.0	1815	5.509	2LP(a)	Lattice	Two latt.-phonons, 17 lines a–q(330), shoulder	…	[Zai01] (Table 3.3)
NA0225b	232.0	1872	5.343	2LP(b)	Lattice	Shoulder	…	[Zai01] (Table 3.3)
NA0225c	244.0	1968	5.080	2LP(c)	Lattice	Strong peak, abs. coeff. 12.3–14.9 cm^{-1}	3.7, **3.10,** **7.**171	[Jan91, Enc94, Fer96]
NA0225d	247.1	1993	5.018	2LP(d)	Lattice	Shoulder	…	[Zai01] (Table 3.3)
NA0225e	251.1	2025	4.938	2LP(e)	Lattice	Strong peak, abs. coeff. 12.3–14.9 cm^{-1}	3.7, **3.10,** **7.**171	[Jan91, Enc94, Fer96]
NA0225f	253.1	2041	4.899	2LP(f)	Lattice	Shoulder	…	[Zai01] (Table 3.3)
NA0225g	258.1	2082	4.804	2LP(g)	Lattice	Weak peak	**3.10**	[Enc94, Zai01] (Table 3.3)
NA0225h	262.0	2114	4.731	2LP(h)	Lattice	Shoulder	…	[Zai01] (Table 3.3)

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NA0225i	267.0	2154	4.642	Lattice	Strong peak, abs. coeff. 12.3–14.9 cm^{-1}	**3.7**, **3.10**, **7.**171	[Jan91,Enc94, Fer96]
NA0225j	270.0	2178	4.591	Lattice	Shoulder	. . .	[Zai01] (Table 3.3)
NA0225k	274.0	2210	4.524	Lattice	Shoulder	. . .	[Zai01] (Table 3.3)
NA0225-l	281.0	2267	4.411	Lattice	Shoulder	. . .	[Zai01] (Table 3.3)
NA0225m	289.0	2331	4.290	Lattice	Shoulder	. . .	[Zai01] (Table 3.3)
NA0225n	292.0	2356	4.245	Lattice	Shoulder	. . .	[Zai01] (Table 3.3)
NA0225o	302.1	2436	4.104	Lattice	Medium strong peak, abs. coeff. 4.9 cm^{-1}	**3.7**, **3.10**, **7.**171	[Jan91,Enc94, Fer96]
NA0225p	315.0	2541	3.935	Lattice	Medium strong peak, abs. coeff. 4.9 cm^{-1}	**3.7**, **3.10**, **7.**171	[Jan91,Enc94, Fer96]
NA0225q	330.0	2662	3.756	Lattice	Shoulder	. . .	[Zai01] (Table 3.3)
Na0304a	304.2	2454	4.076	B$_1$	Boron-acceptor, 18 lines a–r(0.3720 eV); 1a, b → 2	**5.2**, **7.**172	[Smi62,Enc94, Zai01]
Na0304b	335.6	2707	3.694	B$_1$	1b → 3	**5.2**	[Smi62,Zai01] (Table 5.1)
Na0304c	337.3	2721	3.676	B$_1$	1a → 3	. . .	[Zai01] (Table 5.1)
Na0304d	340.4	2746	3.642	B$_1$	see Table 9.2.1	. . .	[Zai01] (Table 5.1)
Na0304e	341.5	2754	3.631	B$_1$	1b → 4	**5.2**	[Smi62,Zai01] (Table 5.1)
Na0304f	342.1	2759	3.624	B$_1$	see Table 9.2.1	. . .	[Zai01] (Table 5.1)

Table 2.1.2.2 Natural diamond: **absorption** lines, mid infrared, Part 2 (0.343–0.47 eV)

Line-label	Energy (meV)	Frequ. (cm^{-1})	Wavel. (μm)	Name	Impur./defect	Comment	Figs. 3–6. [Zai01]; Fig. 7. [Zai98]	References
NA0304g	343.5	2771	3.609	B-acc.(g)	B_1°	1a → 4	…	[Zai01] (Table 5.1)
NA0304h	345.1	2784	3.593	B-acc.(h)	B_1°	see Table 9.2.1	…	[Zai01] (Table 5.1)
NA0174a–s1	345.4	2786	3.589	CH bend	$*(V_1H_1)^\circ$	2 × nat. CH-bend, see Table 9.3.1	**3.7**; **3.26**, **7.**10	[Dav84b, Fri91a, Fer96]
NA0304i	346.4	2794	3.579	B-acc.(i)	B_1°	see Table 9.2.1	…	[Zai01] (Table 5.1)
NA0304j	347.1	2800	3.572	B-acc.(j)	B_1°	Dominant line; 1b → 5	**5.2**, **7.**172	[Smi62, Enc94, Zai01]
NA0304k	349.1	2816	3.551	B-acc.(k)	B_1°	1a → 5	**5.2**	[Smi62, Zai01]
NA0304-l	352.4	2842	3.518	B-acc.(l)	B_1°	1b → 6	…	[Zai01] (Table 5.1)
NA0304m	354.6	2860	3.497	B-acc.(m)	B_1°	1a → 6	…	[Zai01] (Table 5.1)
NA0304n	355.8	2870	3.485	B-acc.(n)	B_1°	1b → 7	…	[Zai01] (Table 5.1)
NA0304-o	357.9	2887	3.464	B-acc.(o)	B_1	1a → 7	…	[Zai01] (Table 5.1)
NA0192a–s1	362.0	2920	3.425	NH bend	$*(V_1N_1H_1)^\circ$	2 × nat. NH-bend, see Table 9.3.1	**3.**26, **7.**5	[Fri91a]
NA0304p	362.7	2926	3.418	B-acc.(p)	B_1°	1b → 8, medium strong line	**5.2**, **7.**172	[Smi62, Enc94, Zai01]
NA0304q	364.6	2941	3.400	B-acc.(q)	B_1°	1a → 8	…	[Zai01] (Table 5.1)

						Bound to free?		
NA0304r	372.0	3001	3.333	B-acc.(r)	$B_1°$		. . .	[Zai01]
NA0174b	385.2	3107	3.219	CH stretch	$*(V_1H_1)°b$	**Nat. CH stretch**, see Table 9.3.1; ZPL of DAP41 = NA0884a–e	**3.7**, **3.26**, **7.10**	[Dav84b, Fri91a, Fer96]
NA0386a	386.0	3113	3.212	DAP3a	$*(N_1C_1)_i°$	Seven lines a–g(420.8 meV); shell = 38; calc. 385.7 meV; ZPL at 211.5 meV	**3.9**, **7.8**	[Woo83]
NA0386b	389.9	3145	3.180	DAP3b	$*(N_1C_1)_i°$	s = 36; calc. 390.4 meV	**3.9**, **7.8**	[Woo83]
NA0386c	394.4	3181	3.144	DAP3c	$*(N_1C_1)_i°$	s = 34; calc. 395.6 meV	**3.9**	[Woo83]
NA0192b	401.2	3236	3.090	NH stretch	$*(V_1N_1H_1)°$	Nat. NH stretch, see Table 9.3.1	**3.7**, **3.26**, **7.10**	[Dav84b, Fri91a, Fer96]
NA0386d	406.6	3280	3.049	DAP3d	$*(N_1C_1)_i°$	s = 30; calc. 407.5 meV	**3.9**, **7.8**	[Woo83]
NA0386e	410.4	3310	3.021	DAP3e	$*(N_1C_1)_i°$	s = 29; calc. 411.8 meV	**3.9**, **7.8**	[Woo83]
NA0087b	414.5	3343	2.991	CH strech	$*(V_1H_1)°$	Acetylenic sp_1CH_1 strech after natural irradiation, see Table 9.3.2.2	**3.9**, **7.8**	[Woo83]
NA0386f	418.1	3372	2.966	DAP3f	$*(N_1C_1)_i°$	s = 27; calc. 419.1 meV	**3.9**, **7.8**	[Woo83]
NA0386g	420.8	3394	2.946	DAP3g	$*(N_1C_1)_i°$	s = 26; calc. 422.1 meV	**3.9**, **7.8**	[Woo83]
NA0192b	423.8	3418	2.926	NH stretch	$*(V_1N_4H_1)°$	Nat. NH stretch, see Table 9.3.1	3.7	[Fer96]
NA0304a–s1	466.0	3759	2.660	B-acc.(a)-s1	$B_1°$	B-acceptor (a) + phonon(162 meV)	5.2	[Smi62]

Table 2.1.2.3 Natural diamond: absorption lines, mid infrared, Part 3 (0.50–1.24 eV)

Line-label	Energy (meV)	Frequ. (10^3 cm^{-1})	Wavel. (μm)	Name	Impur./defect	Comment	Figs. 3–6. [Zai01]; Fig. 7. [Zai98]	References
NA0304j-s1	508.0	4.098	2.440	B-acc.(j)-s1	B$_1$°	B-acc.(j) + phonon(161 meV)	**5.2**	[Smi62]
NA0174a-s2	516.7	4.168	2.399	CH bend	*(V$_1$H$_1$)°a	3 × nat. CH-bend; see Table 9.3.1	**3.5**, **3.7**, 7.10	[Fri91a,Fer96, Dav84b]
NA0520a	520.0	4.194	2.384	amber(a)	...	Two lines a, b (0.7700), two bands(2.2 and 3.3 eV)	...	[Wal79,Zai01]
NA0304p-s1	527.0	4.251	2.352	B-acc.(p)-s1	B$_1$°	B-acc.(p) + phonon (165 meV)	**5.2**	[Smi62]
NA0174b-s1	557.8	4.499	2.223	CH combin.	*(V$_1$H$_1$)	Nat. CH stretch + bend; see Table 9.3.1	**3.5**, **3.7**, 3.26	[Fri91a,Fer96]
NA0192b-s1	583.2	4.704	2.126	NH combin.	*(V$_1$N$_1$H$_1$)°	Nat. NH stretch + bend; see Table 9.3.1	**3.5**, **7.5**	[Fri91a]
NA0304a-s2	625.0	5.041	1.984	B-acc.(a)-s2	B$_1$°	B-acceptor(a) +2× phonon (161 meV)	**5.2**	[Smi62]
NA0304j-s2	670.0	5.404	1.850	B-acc.(j)-s2	B$_1$°	B-acceptor(j) +2× phonon (162 meV)	**5.2**	[Smi62]
NA0174a-s3	688.7	5.555	1.800	CH bend	*(V$_1$H$_1$)°a	4 × Nat. CH-bend; see Table 9.3.1	**3.5**, **7.5**	[Fri91a]

NA0174b-s2	729.0	5.880	1.701	CH combin.	$*(V_1H_1)^\circ$	Nat. CH stretch $+2\times$ bend; see Table 9.3.1	**3.5, 7.5**	[Fri91a]
NA0174b-s3	752.5	6.070	1.647	CH stretch	$*(V_1H_1)^\circ b$	$2 \times$ Nat. CH stretch (Table 9.3.1)	**3.5, 7.5**	[Fri91a]
NA0520b	770.0	6.211	1.610	amber(b)	...	SBs at 83 and 89 meV	...	[Wal79, Zai01]
NA0304j-s3	830.0	6.695	1.494	B-acc.(j)-s3	B_1°	B-acceptor(j) $+3\times$ phonon (161 meV)	...	[Zai01]
NA0884a	884.0	7.130	1.493	(V_1H_1)-DAP41a	$(V_1H_1)^\circ b$	Five lines a–e(1.068 eV), $s = 7$; calc. 0.898 eV	...	[Fri91a]
NA0884b	929.8	7.500	1.333	(V_1H_1)-DAP41b	$(V_1H_1)^\circ b$	$s = 6$; calc. 0.929 eV	**3.5, 7.5**	[Fri91a]
NA0884c	973.2	7.850	1.274	(V_1H_1)-DAP41c	$(V_1H_1)^\circ b$	$s = 5$; calc. 0.978 eV	**3.5, 7.5**	[Fri91a]
NA0884d	1018	8.215	1.217	(V_1H_1)-DAP41d	$(V_1H_1)^\circ b$	$s = 4$; calc. 1.018 eV	**3.5, 7.5**	[Fri91a]
NA0884e	1068	8.615	1.161	(V_1H_1)-DAP41e	$(V_1H_1)^\circ b$	$s = 3$; calc. 1.109 eV	**3.5, 7.5**	[Fri91a]

Table 2.1.3 Natural diamond: absorption lines, near infrared (1.24–1.77 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. 3–6. [Zai01]; Fig. 7. [Zai98]	References
NA1401a	1.401	11.30	884.9	1Ni1.40a	*$V_1Ni_1^+$	Two lines a, b (2.7 meV splitting); ^{58}Ni; other isotopes; see Table 7.5	...	[Zai01]
NA1401b	1.404	11.32	883.2	1Ni1.40b	*$V_1Ni_1^+$	^{58}Ni; ZPL of DAP25, see HA1485a-k	...	[Zai01]
NA1500	1.500	12.10	826.5	**N1**-line	...	SBs at $+60$ and $+180$ meV	**5.14**, **7.60**	[Cla56a, Wal79]
NA1563a	1.563	12.60	793.4	*S5-DAP60a	$(V_2Ni_1)N_x$	Seven lines a-g(2.320 eV), lines b-g; see ME, $s = 162$, calc. 1.564 eV; ESR-cent. NE 8?	...	[Zai01]
NA1673	1.673	13.49	741.0	...	...	ZPL of C-band, 2SBs with 23 meV	**5.29**, **5.137**	[Wig71, Rei98]
NA1682a	1.681	13.56	737.5	*2Si1.68 eV	$(V_3Si_2)^+$	ZPL of DAP53a-m, see LA, LE, Table 8.1.6	...	[Sol72, Zai01]
NA1743a	1.743	14.06	711.2	DAP9a	*N_1^+ B_1°	Twenty-three lines a-w(2.270 eV); $s = 162$; calc. 1.745; lines c, e-i, p, s-w, see NL; $L = 1.641$ eV	**5.137**	[Rei98]
NA1743b	1.766	14.24	702.2	DAP9b	*N_1^+ B_1°	$s = 106$; calc. 1.770 eV; line DAP9c; see NL	**5.137**	[Rei98]

Table 2.1.4 Natural diamond: absorption lines, visible: purple-to-ultramarine (1.77–2.75 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. **3–6.** [Zai01]; Fig. **7.** [Zai98]	References
NA1743d	1.795	14.48	690.6	DAP9d	*N$_1^+$ + B$_1^\circ$	s = 74; calc. 1.795 eV; lines DAP9e–i, NL	5.137	[Rei98]
NA1743j	1.913	15.43	648.1	DAP9j	*N$_1^+$ + B$_1^\circ$	s = 24; calc. 1.912 eV	5.137	[Rei98]
NA1743k	1.929	15.56	642.7	DAP9k	*N$_1^+$ + B$_1^\circ$	s = 22; calc. 1.923 eV	5.137	[Rei98]
NA1743-l	1.934	15.60	641.0	DAP9-l	*N$_1^+$ + B$_1^\circ$	s = 20; calc. 1.938 eV	5.137	[Rei98]
NA1743m	1.952	15.74	635.3	DAP9m	*N$_1^+$ + B$_1^\circ$	s = 18; calc. 1.953 eV	5.137	[Rei98]
NA1743n	1.967	15.87	630.1	DAP9n	*N$_1^+$ + B$_1^\circ$	s = 16; calc. 1.972 eV	5.137	[Rei98]
NA1743-o	2.003	16.16	618.8	DAP9-o	*N$_1^+$ + B$_1^\circ$	s = 14; calc. 1.996 eV; line DAP9p see NL	5.137	[Rei98]
NA1743q	2.029	16.37	610.9	DAP9q	*N$_1^+$ + B$_1^\circ$	s = 12; calc. 2.023 eV	5.137	[Rei98]
NA1743r	2.057	16.59	602.8	DAP9r	*N$_1^+$ + B$_1^\circ$	s = 10; calc. 2.060 eV; lines DAP9s–w, see NL	5.137	[Rei98]
NA2145	2.145	17.30	578.0	...	...	ZPL of red luminescence band	...	[Zai01]
NA2152	2.152	17.36	576.0	...	...	NBD	...	[Col02]
NA2154	2.154	17.38	575.5	**NV**	V$_1$N$_1^\circ$	Named 575 nm center	...	[Zai01]
NA2202	2.202	17.76	563.0	...	H?	NBD; QLVM SBs at +32 and +72 meV	7.74	[Fri91a]
NA2370	2.370	19.12	523.2	**"A"** line	*V$_1$Ni$_3^\circ$	ZPL of DAP91a–g(2.641), see MA	...	[Nad93, Zai01]
NA2424	2.424	19.55	511.5	....	....	NBD	...	[Zai01]

(continued)

Table 2.1.4 (continued)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. 3–6. [Zai01]; Fig. 7. [Zai98]	References
NA2464a	2.464	19.88	503.2	**H3**a	*V_1N_2°	Two lines a, b (3.361 eV); ZPL of DAP50, see MA	...	[Zai01]
NA2490	2.467	19.90	502.5	...	...	NBD; var. 2.460–2.490 eV	**5.87**, **6.**2	[Wel94, Col97]
NA2496a	2.496	20.13	496.7	**S3**-DAP58a	*$(V_2Ni_1)N_2$	Eight lines a–h(2.652); $s = 162$, calc. 2.494 eV	...	[Zai01]
NA2526	2.526	20.38	490.8	...	N?	SBs at 80, 106, 143 meV	...	[Zai01]
NA2496b	2.592	20.91	478.3	**S3**-DAP58b	*$(V_2Ni_1)N_2$	$s = 50$, calc. 2.582 eV	...	[Zai01]
NA2596	2.596	20.94	477.6	**N2**-line	...	Three SBs at $+89$, $+154$, and $+241$ meV	**5.14**, **7.**60, **5.**126	[Cla56a, Col97]
NA2515e	2.597	20.95	477.4	**S2**-DAP57e	*$(V_2Ni_1)N_3$	Fifteen lines a–o, see H/MA, $s = 64$, calc. 2.598 eV, **C**-line	**7.**104	[Yel92a, Yel92b, Nad93]
NA2496c	2.599	20.97	477.0	**S3**-DAP58c	*$(V_2Ni_1)N_2$	$s = 42$, calc. 2.601 eV	...	[Zai01]
NA2615	2.615	21.10	474.0	...	H?	NBD	**7.**74	[Fri91a]
NA2496d	2.622	21.15	472.8	**S3**-DAP58d	*$(V_2Ni_1)N_2$	$s = 34$, calc. 26244 eV	...	[Zai01]
NA2515f	2.623	21.16	472.7	**S2**-DAP57f	*$(V_2Ni_1)N_3$	$s = 50$, calc. 2.621 eV, **D**-line, ESR: NE3	**7.**104	[Yel92a, Yel92b, Nad93]
NA2515h	2.634	21.25	470.7	**S2**-DAP57h	*$(V_2Ni_1)N_3$	$s = 42$, calc. 2.640 eV, named **E**-line	**7.**104	[Yel92a, Yel92b, Nad93]
NA2496e	2.658	21.44	466.4	**S3**-DAP58e	*$(V_2Ni_1)N_2$	$s = 26$, calc. 2.663 eV	...	[Zai01]

Table 2.1.5 Natural diamond: absorption lines, visible: violet (2.75–3.10 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. **3–6** [Zai01]; Fig. **7** [Zai98]	References
NA2767	2.767	22.32	448.1	…	H?	NGD	…	[Fri91a]
NA2792	2.792	22.52	444.0	…	H?	NGD	…	[Fri91a]
NA2818	2.818	22.73	439.9	…	Si?	NBD	7.74, **7.89**	[Fri91a]
NA2870	2.870	23.15	432.0	…	H?	NBD	7.74	[Fri91a]
NA2910	2.910	23.47	426.0	…	*N_2^+?	NGD	**5**.137	[Rei98]
NA2916	2.916	23.52	425.2	…	H?	NGD	7.89	[Fri91a]
NA2649e	2.960	23.88	418.8	DAP18e	*N_2^+ + B_1°	DAP18a–h, $s = 4$, calc. 2.967 eV, lines a–d, see NL	**3**.137	[Rei98, Col82b]
NA2985	2.985	24.08	415.3	**N3**(c)	$V_1N_3^\circ$(c)	Lines **N3** (a, b) see NL; ZPL of DAP23 a–p, see NA	7.89, **7**.141	[Cla65, Fri91a]
NA2649f	3.060	24.68	405.2	DAP18f	*N_2^+ + B_1°	$s = 3$, calc. 3.058 eV, lines g, h, see NL	**3**.137	[Rei98, Col82b]
NA3070	3.070	24.76	403.8	…	H?	NGD	7.89	[San94]
NA3075a	3.075	24.80	403.2	V_1N_3(c)-DAP23a	$V_1N_3^\circ$(c)	Fifteen lines a–o(3.762); $s = 162$, calc. 3.075 eV	**7**.141	[Cla65, Fuc96]

Table 2.1.6 Natural diamond: absorption lines, near ultraviolet (3.10–3.94 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. **3–6** [Zai01]; Fig. **7** [Zai98]	References
NA3075b	3.131	25.26	396.0	V_1N_3(c)-DAP23b	$V_1N_3^{\,\circ}$	$s = 64$, calc. 3.129 eV	**7**.141	[Cla65, Fuc96]
NA3131	3.131	25.26	396.0	⋯		NGD (pink)	**6**.2	[Wel94]
NA3075c	3.136	25.29	395.4	V_1N_3(c)-DAP23c	$V_1N_3^{\,\circ}$	$s = 58$, calc. 3.137 eV	**7**.141	[Cla65, Fuc96]
NA3075d	3.141	25.34	394.7	V_1N_3(c)-DAP23d	$V_1N_3^{\,\circ}$	$s = 54$, calc. 3.142 eV	**7**.141	[Cla65, Fuc96]
NA3075e	3.146	25.38	394.0	V_1N_3(c)-DAP23e	$V_1N_3^{\,\circ}$	$s = 50$, calc. 3.147 eV	**7**.141	[Cla65, Fuc96]
NA3075f	3.167	25.54	391.5	V_1N_3(c)-DAP23f	$V_1N_3^{\,\circ}$	$s = 42$, calc. 3.163 eV	**7**.141	[Cla65, Fuc96]
NA3179	3.179	25.64	390.0	⋯		NGD (pink)	⋯	[Zai01]
NA3075g	3.181	25.66	389.7	V_1N_3(c)-DAP23g	$V_1N_3^{\,\circ}$	$s = 34$, calc. 3.183 eV	**7**.141	[Cla65, Fuc96]
NA3075h	3.229	26.04	383.9	V_1N_3(c)-DAP23h	$V_1N_3^{\,\circ}$	$s = 22$, calc. 3.231 eV	**7**.141	[Cla65, Fuc96]
NA3260	3.260	26.30	380.3	⋯	H?	var. 3.229–3.262 eV	⋯	[Zai01]
NA3075i	3.292	26.55	376.6	V_1N_3(c)-DAP23i	$V_1N_3^{\,\circ}$	$s = 14$, calc. 3.292 eV	**7**.141	[Cla65, Fuc96]
NA3075j	3.317	26.75	373.8	V_1N_3(c)-DAP23j	$V_1N_3^{\,\circ}$	$s = 12$, calc. 3.317 eV	**7**.141	[Cla65, Fuc96]

NA3075k	3.331	26.87	372.1	$V_1N_3(c)$-DAP23k	$V_1N_3^{\circ}$	$s = 11$, calc. 3.336 eV	**7.141**	[Cla65,Fuc96]
NA3333b	3.378	27.25	367.0	*S4-DAP59b	*$(V_2Ni_1)N_3$	$s = 50$, calc. 3.378 eV; other lines see MA	…	[Zai01]
NA3075-l	3.391	27.35	365.6	$V_1N_3(c)$-DAP23-l	$V_1N_3^{\circ}$	$s = 8$, calc. 3.392 eV	**7.141**	[Cla65,Fuc96]
NA3075m	3.542	28.57	350.0	$V_1N_3(c)$-DAP23m	$V_1N_3^{\circ}$	$s = 4$, calc. 3.532 eV	**7.141**	[Cla65,Fuc96]
NA3593	3.593	28.98	345.1	…	…	…		[Zai01]
NA3075n	3.603	29.06	344.1	$V_1N_3(c)$-DAP23n	$V_1N_3^{\circ}$	$s = 3$, calc. 3.610 eV; named **N4**-line	…	[Wal79,Fuc96, Zai01]
NA3075-o	3.682	29.70	336.7	$V_1N_3(c)$-DAP23-o	$V_1N_3^{\circ}$	$s = 2$, calc. 3.653 eV	…	[Wal79,Fuc96, Zai01]
…..NA3075p	3.762	30.34	329.6	$V_1N_3(c)$-DAP23p	$V_1N_3^{\circ}$	$s = 1$, calc. 3.730 eV; named **N5**-line	…	[Wal79,Fuc96, Zai01]
NA3877	3.877	31.27	319.8	…		…	…	[Rob34,Cla56a, Ily71b]
NA3901	3.901	31.46	317.8	DAP52g	*$V_1N_2^{\circ}$	$s = 4$, calc. 3.911 eV; lines (a–f), see MA	…	[Wal79,Zai01]
NA3928	3.928	31.68	315.6	**N6**-line= *A(a)	N_2°	Two lines a, b (4.470 eV), see Table 9.1.1.3	…	[Wal79,Zai01]

Table 2.1.7 Natural diamond: absorption lines, mid ultraviolet (3.94–4.43 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. 3–6 [Zai01]; Fig. 7 [Zai98]	References
NA4022	4.022	32.44	308.2	...	*V_1N_2°	...	...	[Zai01]
NA3928-s1	4.041	32.60	306.8	**N7** = DAP52h	N_1°	$s = 2$, calc. 4.034 eV	...	[Wal79,Zai01]
NA4059	4.059	32.74	305.4	C-cent.(c)	N_1°	One UV line; Seven IR lines a'–g'(0.1666 eV); see Table 9.1.1.1; 2 QLVM at +61 meV (3C)	**5**.164	[Naz87,Col97]
NA4088	4.088	32.97	303.3	...	?	var. 4.084–4.088, N6+160 meV?	...	[Wal79,Zai01]
NA4137a	4.137	33.37	299.7	...	N?	Four lines a–d(4.355)	...	[Dav77c]
NA4184f	4.184	33.75	296.3	**B**-cent.(a1)	V_1N_4°	Three UV lines a1–a3(4.197 eV), seven IR lines a'–g'(0.165 eV); see Table 8.1.3.5; SB +36 meV	...	[Naz87,Zai01]
NA4190	4.190	33.80	295.9	**N8**-line	N?	...	...	[Wal79,Zai01]
NA4184g	4.191	33.81	295.8	**B**-cent.(a2)	V_1N_4°	ZPL of DAP82a–e; SB at +36 meV (QLVM)	...	[Naz87,Zai01]
NA4184h	4.197	33.85	295.4	**B**-cent.(a3).	V_1N_4°	SBs at +36, +72 meV	...	[Naz87,Zai01]
NA4137b	4.270	34.44	290.3	...	N?	...	...	[Dav77c]
NA4307a	4.307	34.74	287.9	B(a)-DAP82a	V_1N_4°	Five lines a–e(4.438 eV); $s = 130$, calc. 4.310 eV	...	[Naz87]
NA4137c	4.316	34.81	287.3	...	N?	...	...	[Dav77c]
NA4307b	4.350	35.09	285.0	B(a)-DAP82b	V_1N_4°	$s = 72$, calc. 4.350 eV	...	[Naz87]
NA4137d	4.355	35.13	284.7	...	N?	...	...	[Dav77c]
NA4374	4.374	35.28	283.4	...		Weak line	...	[Zai01]
NA4307c	4.400	35.49	281.8	B(a)-DAP82c	V_1N_4°	$s = 42$, calc. 4.400 eV	...	[Naz87]
NA4307d	4.423	35.68	280.3	B(a)-DAP82d	V_1N_4°	$s = 34$, calc. 4.423 eV	...	[Naz87]

Table 2.1.8 Natural diamond: absorption lines, far ultraviolet (4.43–5.90 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. **3–6** [Zai01]; Fig. **7** [Zai98]	References
NA4307e	4.438	35.80	297.4	B(a)-DAP82e	$V_1N_4{}^\circ$	$s = 30$, calc. 4.437 eV	...	[Naz87]
NA4468	4.470	36.06	277.4	*A(b)	$N_2{}^\circ$	See Table 9.1.1.3	...	[Naz87]
NA4567	4.567	36.84	271.5	**F-cent.(c)**	$V_1N_4(C_2)i^\circ$	2 vis. +1 UV line; Nine IR lines a–i; see Table 8.1.3.6 ZPL of DAP81a–g; SBs +55, 106, 136, 154 meV	**5.164**	[Naz87, Col97]
NA4646	4.646	37.48	266.8	...		...	...	[Zai01]
NA4721a	4.721	38.08	262.6	F(c)-DAP81a	$V_1N_4(C_2)i^\circ$	Seven lines a–g(4.906 eV); $s = 86$, calc. 4.722 eV	...	[Naz87]
NA4721b	4.748	38.30	261.1	F(c)-DAP81b	$V_1N_4(C_2)i^\circ$	$s = 64$, calc. 4.747 eV	...	[Naz87]
NA4721c	4.775	38.52	259.6	F(c)-DAP81c	$V_1N_4(C_2)i^\circ$	$s = 50$, calc. 4.770 eV	...	[Naz87]
NA4721d	4.814	38.83	257.5	F(c)-DAP81d	$V_1N_4(C_2)i^\circ$	$s = 34$, calc. 4.814 eV	...	[Naz87]
NA4721e	4.835	39.00	256.4	F(c)-DAP81e	$V_1N_4(C_2)i^\circ$	$s = 30$, calc. 4.831 eV	...	[Naz87]
NA4721f	4.880	39.36	254.1	F(c)-DAP81f	$V_1N_4(C_2)i^\circ$	$s = 22$, calc. 4.876 eV	...	[Naz87]
NA4721g	4.906	39.57	252.7	F(c)-DAP81g	$V_1N_4(C_2)i^\circ$	$s = 18$, calc. 4.908 eV	...	[Naz87]
NA4990a	4.990	40.25	248.5	**N10a**–line		Two lines a, b (5.165 eV), closely related to N9	...	[Bok86, Zai01]
NA4990b	5.165	41.66	240.0	**N10b**-line		...	...	[Bok86, Zai01]
NA5252a	5.252	42.36	236.1	**N9a**	*$V_1N_4{}^-$	Three lines a–c(5.277 eV), ZPL of N9a–DAP63a–g	**5.158**, 7.169a	[Bok86, Col97]

Table 2.1.8 (continued)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. **3–6** [Zai01]; Fig. **7** [Zai98]	References
NA5252b	5.262	42.44	235.6	**N9b**	*V$_1$N$_4$ —	ZPL of N9b (similar DAP as-N9a–DAP63)	**5.158, 7.169a**	[Bok86, Col97]
NA5277	5.277	42.56	234.9	**N9c**	*V$_1$N$_4$ —	Very weak line (2% of lines a, b)	5.158	[Col97]
NA5340a	5.340	43.07	232.2	N9a–DAP63a	*V$_1$N$_4$ —	Four lines (+3 PLE lines, see NE), $s = 198$, calc. 5.340 eV; also photocond. Spectrum [Den67]	5.158	[Col97]
NA5350a	5.350	43.15	231.7	N9b–DAP-a	*V$_1$N$_4$ —	Three lines a–d(5.410 eV); $s = 162$, calc. 5.350 eV	5.158	[Col97]
NA5340b	5.370	43.31	230.9	N9a–DAP63b	*V$_1$N$_4$ —	Three lines b–d(5.420 eV); $s = 106$, calc. 5.372 eV	5.158	[Col97]
NA5340c	5.388	43.46	230.1	N9a–DAP63c	*V$_1$N$_4$ —	$s = 78$, calc. 5.392 eV	5.158	[Col97]
NA5350c	5.398	43.54	229.6	N9b–DAP-b	*V$_1$N$_4$ —	$s = 78$, calc. 5.402 eV	5.158	[Col97]
NA5340d	5.410	43.64	229.1	N9a–DAP63d	*V$_1$N$_4$ —	$s = 64$, calc. 5.406 eV; N9a-DAP63e–g, see NE	5.158	[Col97]
NA5350d	5.420	43.72	228.7	N9b–DAP-c	*V$_1$N$_4$ —	$s = 50$, calc. 5.416 eV	5.158, 7.169a	[Bok86, Col97]

2.2   Excitation of Photoluminescence Lines (NE)

Table 2.2.1 Natural diamond: excitation of photoluminescence lines (PLE), visible: blue to violet (2.43–3.10 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. 3–6 [Zai01]; Fig. 7 [Zai98]	References
NE2496a	2.496	20.13	496.7	*Ni-S3-DAP58a	$(V_2Ni_1)N_{2+0+0}$	Eight lines a–h(2.652); $s = 162$, calc. 2.494 eV, named **S3a**	...	[Zai01]
NE2537b	2.597	20.95	477.4	*Ni-S2-DAP57b	$(V_2Ni_1)N_{2+0+1}$	Seven lines a–g(3.341 eV), lines (a–e) see NL; $s = 64$, calc. 2.598 eV, named **S2b**, **C**-line; ESR: NE3	...	[Zai01]
NE2496c	2.599	20.97	477.0	*Ni-S3-DAP58c	$(V_2Ni_1)N_{2+0+0}$	$s = 42$, calc. 2.601 eV, named **S3c**; lines a, b; see NA	...	[Zai01]
NE2496d	2.622	21.15	472.8	*Ni-S3-DAP58d	$(V_2Ni_1)N_{2+0+0}$	$s = 34$, calc. 26244 eV, named **S3d**	...	[Zai01]
NE2496e	2.652	21.39	467.5	*Ni-S3-DAP58e	$(V_2Ni_1)N_{2+0+0}$	$s = 26$, calc. 2.660 eV, named **S3e**	...	[Zai01]
NE2721	2.721	21.95	455.6	PLE of Yellow 2band	$*N_2{}^\circ + B_1{}^-$	NBD, sharp feature on the 2.91-eV band (SBs at 38.5 meV); DAP18c, $s = 12$, calc. 2.719 eV; see NA, NL	...	[Zai01]
NE2985	2.985	24.08	415.3	**N3**(c) = V$_1$N$_3$(c)	$V_1N_3{}^\circ$	ZPL of DAP23; PLE of lines N3 (a, b)	5.93 = 7.99, 5.140	[Sob76, Iak00a]
NE3075a	3.075	24.80	403.2	V$_1$N$_3$(c)-DAP23a	$V_1N_3{}^\circ$	PLE of N3(a–c); 15 lines a–o(3.762 eV); $s = 162$, calc. 3.075 eV	5.93, 5.140, 7.151	[Sob76, Iak00a, Cla70]

Table 2.2.2 Natural diamond: excitation of photoluminescence lines (PLE), near ultraviolet (3.10–3.94 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. **3–6** [Zai01]; Fig. **7** [Zai98]	References
NE2496f	3.234	26.09	383.4	*Ni-S3-DAP58f	$(V_2Ni_1)N_{2+0+0}$	$s = 2$, calc. 3.240 eV, named **S3f**	...	[Zai01]
NE3075b	3.131	25.26	396.0	V_1N_3(c)-DAP23b	$V_1N_3{}^\circ$	$s = 64$, calc. 3.129 eV	7.151	[Cla70]
NE3075c	3.141	25.34	394.7	V_1N_3(c)-DAP23c	$V_1N_3{}^\circ$	$s = 54$, calc. 3.142 eV	5.140, 7.151	[Iak00a, Cla70]
NE3075d	3.146	25.38	394.1	V_1N_3(c)-DAP23d	$V_1N_3{}^\circ$	$s = 50$, calc. 3.147 eV	7.151	[Cla70]
NE3075e	3.167	25.54	391.5	V_1N_3(c)-DAP23e	$V_1N_3{}^\circ$	$s = 42$, calc. 3.163 eV	7.151	[Cla70]
NE3075f	3.181	25.66	389.7	V_1N_3(c)-DAP23f	$V_1N_3{}^\circ$	$s = 34$, calc. 3.183 eV	5.93 = 7.99	[Sob76]
NE3075g	3.229	26.04	383.9	V_1N_3(c)-DAP23g	$V_1N_3{}^\circ$	$s = 22$, calc. 3.231 eV	5.140, 7.151	[Iak00a, Cla70]
NE2537f	3.234	26.09	383.4	*Ni-S2-DAP57f	$(V_2Ni_1)N_{2+0+1}$	$s = 64$, calc. 3.240 eV, named **S2f**	...	[Zai01]
NE3075h	3.292	26.55	376.6	V_1N_3(c)-DAP23h	$V_1N_3{}^\circ$	$s = 14$, calc. 3.292 eV	5.93, 5.140, 7.151	[Sob76, Iak00a, Cla70]

NE3075i	3.317	26.75	373.8	V_1N_3(c)-DAP23i	$V_1N_3^\circ$	$s = 12$, calc. 3.317 eV	5.140, 7.151	[Iak00a, Cla70]
NE2537g	3.341	26.95	371.1	*Ni-S2-DAP57g	$(V_2Ni_1)N_{2+0+1}$	$s = 1$, calc. 3.335 eV, named **S3**g	…	[Zai01]
NE3333b	3.380	27.26	366.8	*Ni-S4-DAP59b	$(V_2Ni_1)N_{1+2+0}$	$s = 50$, calc. 3.378; other lines see MA	…	[Zai01]
NE3075j	3.331	26.87	372.2	V_1N_3(c)-DAP23j	$V_1N_3^\circ$	$s = 11$, calc. 3.336 eV	7.151	[Cla70]
NE3075k	3.391	27.35	365.6	V_1N_3(c)-DAP23k	$V_1N_3^\circ$	$s = 8$, calc. 3.392 eV	5.140, 7.151	[Iak00a, Cla70]
NE3075-l	3.542	28.57	350.0	V_1N_3(c)-DAP23-l	$V_1N_3^\circ$	$s = 4$, calc. 3.532 eV	5.93 = 7.99	[Sob76]
NE3075m	3.603	29.06	344.1	V_1N_3(c)-DAP23m	$V_1N_3^\circ$	$s = 3$, calc. 3.610 eV; named **N4**	7.151	[Cla70]
NE3075n	3.682	29.70	336.7	V_1N_3(c)-DAP23n	$V_1N_3^\circ$	$s = 2$, calc. 3.653 eV; line (o) see NA	7.151	[Cla70]

Table 2.2.3 Natural diamond: excitation of photoluminescence lines (PLE), far ultraviolet (4.43–5.90 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. **3–6** [Zai01]; Fig. **7** [Zai98]	References
NE4646	4.646	37.48	266.8	...	...	PLE of green–yellow band	...	[Zai01]
NE4990	4.990	40.25	248.5	**N10a**-line	...	PLE of A bands, closely related to N9	...	[Zai01]
NE5165a	5.156	41.66	240.0	**N10b**-line	...	PLE of N10a and A bands; 166 meV SB of N10a?	7.160	[Dea64c]
NE5165b	5.248	42.33	236.2	...	...	Splitting 5 meV	...	[Zai01]
NE5252a	5.252	42.36	236.1	**N9a** = DAP63z	$*V_1N_4^-$	ZPL of N9a-DAP63a–g	5.135, 5.140, 7.160	[Iak00a, Dea64c]
NE5252b	5.262	42.44	235.6	**N9b**	$*V_1N_4^-$	ZPL of N9b, (similar DAP as N9a)	5.135, 5.140, 7.160	[Iak00a, Dea64c]
NE5340a	5.340	43.07	232.2	N9a-DAP63a	$*V_1N_4^-$	Seven lines a–g(5.527 eV), shell = 198, calc. 5.340 eV; PLE of A-bands, N10	5.135, 5.140, 7.160	[Iak00a, Dea64c, Den67]
NE5340b	5.370	43.31	230.9	N9a-DAP63b	$*V_1N_4^-$	s = 106, calc. 5.372 eV	5.140, 7.160	[Iak00a, Dea64c]
NE5340c	5.388	43.46	230.1	N9a-DAP63c	$*V_1N_4^-$	s = 78, calc. 5.392 eV	5.135, 5.140, 7.160	[Iak00a, Dea64c]
NE5340d	5.410	43.64	229.2	N9a-DAP63d	$*V_1N_4^-$	s = 64, calc. 5.406 eV	5.135, 5.140, 7.160	[Iak00a, Dea64c, Den67]
NE5340e	5.425	43.76	228.5	N9a-DAP63e	$*V_1N_4^-$	s = 50, calc. 5.426 eV	7.160	[Dea64c]

NE5340f	5.497	44.34	225.5	N9a-DAP63f	$*V_1N_4$ —	$s = 26$, calc. 5.495 eV	7.160	[Dea64c]
NE5340g	5.527	44.58	224.3	N9a-DAP63g	$*V_1N_4$ —	$s = 20$, calc. 5.529 eV	5.135, 5.140, 7.160	[Iak00a, Dea64c]
NE5521a	5.521	44.53	224.6	DAP21a	...	Twelve lines a–l(5.889 eV); $s = 98$, calc. 5.526 eV, PLE of A bands	7.160	[Dea64c]
NE5521b	5.571	44.94	222.5	DAP21b	...	$s = 50$, calc. 5.572 eV, PLE of A bands	7.160	[Dea64c]
NE5521c	5.619	45.32	220.6	DAP21c	...	$s = 30$, calc. 5.620 eV, PLE of A bands	5.135, 7.160	[Iak00a, Dea64c]
NE5521d	5.630	45.41	220.2	DAP21d	...	$s = 26$, calc. 5.635 eV, PLE of A bands	7.160	[Dea64c]
NE5521e	5.650	45.57	219.4	DAP21e	...	$s = 24$, calc. 5.645 eV, PLE of A bands	...	[Den67]
NE5521f	5.669	45.73	218.7	DAP21f	...	$s = 20$, calc. 5.667 eV, PLE of A bands	7.160	[Dea64c]
NE5521g	5.704	46.01	217.4	DAP21g	...	$s = 16$, calc. 5.697 eV, PLE of A bands	...	[Den67]
NE5521h	5.719	46.13	216.8	DAP21h	...	$s = 14$, calc. 5.716 eV, PLE of A bands	7.160	[Dea64c]
NE5521i	5.739	46.29	216.0	DAP21i	...	$s = 12$, calc. 5.741 eV, PLE of A bands	5.135, 7.160	[Iak00a, Dea64c]
NE5521j	5.775	46.58	214.7	DAP21j	...	$s = 10$, calc. 5.773 eV, PLE of A bands	7.160	[Dea64c]
NE5521k	5.809	46.86	213.4	DAP21k	...	$s = 8$, calc. 5.815 eV, PLE of A bands	...	[Dea64c]
NE5521-l	5.889	47.50	210.5	DAP21-l	...	$s = 6$, calc. 5.877 eV, PLE of A bands	...	[Dea64c]

2.3   Luminescence Lines (NL)

Table 2.3.1 Natural diamond: luminescence lines, mid infrared (0.18–1.24 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. **3–6** [Zai01]; Fig. **7.** [Zai98]	References
NL0995a	0.995	8.026	1246	D(a)-DAP96a	*$(C_{2n})_i^\circ$	Six lines a–f(1.305 eV), s = 4, calc. 0.992 eV	5.9	[Ruo91a]
NL1053	1.053	8.493	1177	…	…	…	…	[Ruo91a]
NL0995b	1.125	9.074	1102	D(a)-DAP96b	*$(C_{2n})_i^\circ$	s = 8, calc. 1.128 eV	5.9	[Ruo91a]
NL0995c	1.170	9.437	1060	D(a)-DAP96c	*$(C_{2n})_i^\circ$	s = 10, calc. 1.170 eV	5.9	[Ruo91a]
NL0995d	1.240	10.00	1000	D(a)-DAP96d	*$(C_{2n})_i^\circ$	s = 16, calc. 1.245 eV	5.9	[Ruo91a]

Table 2.3.2 Natural diamond: luminescence lines, near infrared (1.24–1.77 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. **3–6** [Zai01]; Fig. **7.** [Zai98]	References
NL0995e	1.262	10.18	982.4	D(a)-DAP96e	*$(C_{2n})_i^\circ$	s = 18, calc. 1.261 eV	5.9	[Ruo91a]
NL1264	1.264	10.20	980.8	…	…	SBs −60 meV	…	[Dav77c]
NL0995f	1.305	10.53	950.0	D(a)-DAP96f	*$(C_{2n})_i^\circ$	s = 64, calc. 1.386 eV	5.9	[Ruo91a]
NL1328	1.328	10.71	933.6	…	…	…	5.11 = 7.56	[Ruo91a]
NL1360	1.360	10.97	911.6	…	…	…	5.11 = 7.56	[Ruo91a]
NL1401a	1.401	11.30	884.9	1Ni1.40a	*$V_1Ni_1^+$	^{58}Ni, ZPL of Ni1.4-DAP26a–k, see HL	…	[Zai01]
NL1401b	1.404	11.32	883.2	1Ni1.40b	*$V_1Ni_1^+$	^{58}Ni, see Table 7.4b (intensities a : b = 40 : 60%)	…	[Zai01]

NL0995z	1.526	12.31	812.4	D(a)-DAP96z	*(C$_{2n}$)$_i$°	ZPL of D(a)-DAP96	**5.9**	[Ruo91a]
NL1559	1.559	12.58	795.2	...	...	...	...	[Bok86]
NL1563	1.563	12.60	793.4	*NiS5-DAP60a	(V$_2$Ni$_1$)N$_{1+x+y}$	Seven lines a–g(2.320 eV), lines b–g see ME, $s = 162$, calc. 1.564 eV; ESR-cent. NE8?	7.63a	[Bok86, Zai01]
NL1573	1.573	12.69	788.2		N?		**5.11 =** 7.56, **7.63a**	[Ruo91a, Bok86]
NL1606	1.606	12.96	771.8	DAP116a	...	Six lines a–f(1.701 eV), $s = 22$, calc. 1.606 eV	...	[Sol72]
NL1619	1.619	13.06	765.6	DAP116b	...	$s = 24$, calc. 1.618 eV	...	[Sol72]
NL1629	1.629	13.14	760.9	DAP116c	...	$s = 26$, calc. 1.628 eV	...	[Sol72]
NL1652	1.652	13.33	750.3	DAP116d	...	$s = 32$, calc. 1.652 eV	...	[Sol72]
NL1658	1.658	13.38	747.6	DAP116e	...	$s = 34$, calc. 1.659 eV	...	[Sol72]
NL1673	1.673	13.49	741.0	(C-band)	...	ZPL of C-band(1.33 eV), 11 SBs at 53–40 meV	**5.29 =** **7.55a**	[Wig71]
NL1633b	1.689	13.62	734.0	DAP4b	*N$_2^+$ + ?	$s = 64$, calc. 1.689 eV, other DAP4 lines see ML	...	[Sol72]
NL1701	1.701	13.72	729.0	DAP116f	...	$s = 54$, calc. 1.702 eV	...	[Sol72]
NL1733f	1.708	13.77	726.2	DAP4f	*N$_2^+$ + ?	$s = 52$, calc. 1.708 eV, other DAP4 lines see ML	...	[Sol72]
NL1743a	1.743	14.06	711.3	DAP9a	*N$_1^+$ + B$_1$°	Twenty-three lines a–w(2.270 eV), lines b, j, l, m, o, see NA; $s = 162$; calc.1.745 eV	**5.29**	[Wig71]
NL1762	1.762	14.21	703.6	...	...	SBs at −33 meV...	...	[Dav77c]
NL1770	1.770	14.28	700.4	...	...	SBs at −40 and −70 meV	**5.11 =** 7.56, 7.63	[Ruo91a, Bok86]

Table 2.3.3 Natural diamond: luminescence lines, visible: purple + red (1.77–2.03 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. 3–6. [Zai01]; Fig. 7. [Zai98]	References
NL1743c	1.775	14.32	698.5	DAP9c	*N$_1^+$ + B$_1^\circ$	$s = 98$; calc. 1.775 eV	5.29...	[Wig71]
NL1785	1.785	14.40	694.4	...	...	...	...	[Sol72]
NL1792a	1.792	14.45	692.1	DAP20a	*N$_2^\circ$ + B$_1^\circ$	Seven lines a–g(2.105 eV), $s = 10$, calc. 1.785	7.132a	[Moh82b]
NL1743d	1.795	14.48	690.7	DAP9d	*N$_1^+$ + B$_1^\circ$	$s = 74$; calc. 1.795 eV	5.29...	[Wig71]
NL1743e	1.818	14.66	681.9	DAP9e	*N$_1^+$ + B$_1^\circ$	$s = 58$; calc. 1.815 eV	5.29...	[Wig71]
NL1819	1.819	14.67	681.6	...	...	NBD	...	[Sol72, Zai01]
NL1743f	1.830	14.76	677.5	DAP9f	*N$_1^+$ + B$_1^\circ$	$s = 50$; calc. 1.828 eV	5.29...	[Wig71, Col82d]
NL1792b	1.831	14.77	677.1	DAP20b	*N$_2^\circ$ + B$_1^\circ$	$s = 8$, calc. 1.829 eV	7.132a	[Moh82b]
NL1844a	1.844	14.87	672.3	DAP65a	*(V$_3$Si$_2$)$^\circ$	Five lines a–e(1.976 eV), $s = 34$, calc. 1.846 eV	7.85a	[San94]
NL1743g	1.862	15.02	665.8	DAP9g	*N$_1^+$ + B$_1^\circ$	$s = 36$; calc. 1.862 eV	5.29...	[Wig71]
NL1792c	1.867	15.06	664.0	DAP20c	*N$_2^\circ$ + B$_1^\circ$	$s = 7$, calc. 1.867 eV	7.132a	[Moh82b]
NL1743h	1.869	15.08	663.3	DAP9h	*N$_1^+$ + B$_1^\circ$	$s = 34$; calc. 1.868 eV	5.29...	[Wig71]
NL1792d	1.890	15.24	656.0	DAP20d	*N$_2$ + B$_1$	$s = 6$, calc. 1.894 eV	7.132a	[Moh82b]
NL1743i	1.899	15.32	652.9	DAP9i	*N$_1^+$ + B$_1^\circ$	$s = 26$; calc. 1.901 eV	5.29...	[Wig71, Col82d]
NL1844b	1.902	15.34	651.8	DAP65b	*(V$_3$Si$_2$)$^\circ$	$s = 64$, calc. 1.902 eV	7.85a, 7.87a, 7.94a	[San94]

NL	eV		nm	DAP	Defect	Comment	Lines	Ref.
NL1844c	1.915	15.45	647.4	DAP65c	*$(V_3Si_2)°$	$s = 78$, calc. 1.916 eV	**7.85a, 7.87a, 7.94a**	[San94]
NL1743k	1.929	15.56	642.7	DAP9k	*$N_1^+ + B_1°$	$s = 22$; calc. 1.923 eV	**5.29...**	[Wig71, Col82d]
NL1792e	1.937	15.62	640.0	DAP20e	*$N_2° + B_1°$	$s = 5$, calc. 1.938 eV	**7.132a**	[Moh82b]
NL1946	1.946	15.70	637.1	...	...	NBD, SB at -42 meV	...	[Naz85a, Fie92]
NL1844d	1.951	15.74	635.5	DAP65d	*$(V_3Si_2)°$	$s = 130$, calc. 1.946 eV	**7.85a, 7.87a, 7.94a**	[San94]
NL1743n	1.967	15.87	630.3	DAP9n	*$N_1^+ + B_1°$	$s = 16$; calc. 1.972 eV	**5.29...**	[Wig71, Col82d]
NL1844e	1.976	15.94	627.4	DAP65e	*$(V_3Si_2)°$	$s = 228$, calc. 1.973 eV	**7.85a, 7.87a, 7.94a**	[San94]
NL1792f	1.980	15.97	626.1	DAP20f	*$N_2° + B_1°$	$s = 4$, calc. 1.974 eV	**7.132a**	[Moh82b]
NL1750c	2.001	16.14	619.4	DAP73c	*$V_1B_1°$(a)	$s = 8$, calc. 1.997 eV; a–f(2.240 eV); see ML	...	[Dea65a, Zai01]
NL2006a	2.006	16.18	618.0	N3(a)-DAP55a	$V_1N_3°$(a)	5 lines a–e (2.207 eV), $s = 16$, calc. 2.010 eV	**5.93 =** 7.99	[Sob76]
NL1743p	2.007	16.19	617.7	DAP9p	*$N_1^+ + B_1°$	$s = 13$; calc. 2.011 eV	**5.29...**	[Wig71]
NL1743q	2.023	16.32	612.8	DAP9q	*$N_1^+ + B_1°$	$s = 12$; calc. 2.023 eV	...	[Col82d]
NL2024	2.024	16.33	612.4	...	...	...	**5.64**	[Zai01]

Table 2.3.4 Natural diamond: luminescence lines, visible: orange (2.03–2.10 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. **3–6** [Zai01]; Fig. **7** [Zai98]	References
NL2034	2.034	16.41	609.5	...	...	...	...	[Gom60a, Zai01]
NL2041a	2.041	16.46	607.4	DAP75a	*$(V_3Si_2)^-$	Ten lines a–j(2.450 eV), $s = 6$, calc. 2.042	7.118	[Gra94]
NL2006b	2.049	16.53	605.1	DAP55b	$V_1N_3{}^\circ$(a)	$s = 22$, calc. 2.051	5.93 = 7.99	[Sob76]
NL2051	2.051	16.54	604.5	...	...	NBD, 8 SBs with 28–36 meV	7.132	[Moh82b]
NL1844z	2.053	16.56	603.9	DAP65z	*$(V_3Si_2)^\circ$	ZPL of DAP65a–e(1.976 eV), QLVM(2Si) 45 meV	7.85a, 7.87, 7.94	[San94]
NL1743r	2.057	16.59	602.7	DAP9r	*$N_1{}^+ + B_1{}^\circ$	$s = 10$; calc. 2.060 eV	5.29...	[Wig71, Col82b]
NL1750d	2.062	16.63	601.2	DAP73d	*$V_1B_1{}^\circ$(a)	$s = 12$, calc. 2.070	...	[Dea65a]
NL2070a	2.070	16.70	598.9	DAP1a	*$N_1{}^\circ + B_1{}^\circ$	Twelve lines a–m(2.668 eV), $s = 50$, calc. 2.067, obs. 2.10		[Dea64c]
NL2082a	2.082	16.79	595.5	...	...	NBD...	7.87a, 7.94a	[San94]
NL2088	2.088	16.84	593.8	...	...	NBD...	7.87a, 7.94a	[San94]
NL1743s	2.089	16.85	593.5	DAP9s	*$N_1{}^+ + B_1{}^\circ$	$s = 9$; calc. 2.089 eV	5.29...	[Wig71]
NL2095a	2.095	16.90	591.8	DAP19a	*$N_2{}^\circ + B_1{}^-$	NBD; ten lines a–j(2.645 eV), $s = 32$, calc. 2.089 eV	7.132	[Moh82b]
NL2096	2.096	16.91	591.5	...	...	NBD, SB at ~30 meV	...	[Jor83, Per86]
NL2099	2.099	16.93	590.6	...	...	...	...	[Bok86]
NL2100a	2.100	16.94	590.4	S1b-DAP43a	*$V_1N_1{}^\circ$	Seven lines a–g(2.372 eV), $s = 16$, calc. 2.099 eV	7.110	[Sob69c, Zai01]

Table 2.3.5 Natural diamond: luminescence lines, visible: yellow (2.10–2.18 eV)

Line-label	Energy (eV)	Frequ. ($10^3\,cm^{-1}$)	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. **3–6** [Zai01]; Fig. **7.** [Zai98]	References
NL1792g	2.105	16.98	589.0	DAP20g	$*N_2{}^\circ + B_1{}^\circ$	$s = 2$, calc. 2.100	7.132a	[Moh82b]
NL2070b	2.108	17.00	588.1	DAP1b	$*N_1{}^\circ + B_1{}^\circ$	$s = 34$, calc. 2.105, obs. 2.10		[Dea64c]
NL1743t	2.112	17.06	586.3	DAP9t	$*N_1{}^+ + B_1{}^\circ$	$s = 8$; calc. 2.109	…	[Col82d]
NL2006c	2.116	17.07	585.9	DAP55c	$V_1 N_3{}^\circ(a)$	$s = 42$, calc. 2.119	$5.93 = 7.99$	[Sob76]
NL2131	2.131	17.18	581.9	…	…	NBD, SB at $-30\,meV$	…	[Per86]
NL2041b	2.132	17.20	581.5	DAP75b	$*(V_3 Si_2)^-$	$s = 8$, calc. 2.141	7.118	[Gra94]
NL2134	2.134	17.21	581.0	…	…	SBs at $-30\,meV$	…	[Zai01]
NL2137	2.137	17.24	580.1	…	…	NBD, SBs at $-30\,meV$	…	[Per86]
NL2100b	2.137	17.24	580.1	S1b-DAP43b	$*V_1 N_1{}^\circ$	$s = 18$, calc. 2.131 eV	7.110	[Sob69c, Zai01]
NL1743u	2.138	17.25	579.9	DAP9u	$*N_1{}^+ + B_1{}^\circ$	$s = 7$; calc. 2.150 eV	5.29…	[Wig71]
NL2095b	2.140	17.26	579.3	DAP19b	$*N_2{}^\circ + B_1{}^-$	NBD; $s = 20$ calc. 2.142 eV	5.130, 7.132	[Per88, Moh82b]
NL2143	2.143	17.28	578.6	…	…	…	…	[Zai01]
NL2145	2.145	17.30	578.0	…	…	ZPL of red band (NB1805); 10 SBs with $-30\,meV$	7.92a	[San90]
NL2151	2.151	17.35	576.4	…	…	NBD, SB at $-30\,meV$	…	[Per86]
NL2154	2.154	17.38	575.5	**NV**	$V_1 N_1{}^\circ$	var. 2.153–2.156 eV; ZPL of DAP47a–h, see ML	5.64, 7.64, 7.94b	[Bok86, San94]

(continued)

Table 2.3.5 (continued)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. 3–6 [Zai01]; Fig. 7. [Zai98]	References
NL2157	2.157	17.40	574.8	...	...	NBD; related to NL2082?	7.87b	[Zai01]
NL2052b	2.163	17.45	573.2	...	...	Related to NL2053 (*$(V_3Si_2)^\circ$ – DAP65)?	...	[San94]
NL2164a	2.164	17.45	572.9	DAP76a	*$V_1N_3{}^-$	Thirteen lines a–g(2.457 eV), $s = 8$, calc. 2.162 eV	5.120b	[Naz92]
NL2095c	2.165	17.46	572.6	DAP19c	*$N_2{}^\circ + B_1{}^-$	NBD; $s = 16$ calc. 2.171 eV	5.130, 7.132	[Per88, Moh82b]
NL2167	2.167	17.48	572.1	...	...	SBs at ~30 meV	...	[Zai01]
NL2006d	2.175	17.54	570.0	DAP55d	$V_1N_3{}^\circ$(a)	$s = 86$, calc. 2.173	5.93 = 7.99	[Sob76]
NL2082b	2.175	17.54	570.0	...	...	NBD, related to 2.082 line?	7.87b, 7.94b	[San94]
NL1743v	2.180	17.58	568.7	DAP9v	*$N_1{}^+ + B_1{}^\circ$	$s = 6$; calc. 2.183 eV	...	[Col82d]

Table 2.3.6.1 Natural diamond: luminescence lines, visible: green, Part 1 (2.18–2.36 eV)

Line-label	Energy (eV)	Frequ. ($10^3\ cm^{-1}$)	Wavel. (nm)	Name	Impur./defect	Comment	Figs. 3–6 [Zai01]; Fig. 7. [Zai98]	References
NL2164b	2.189	17.66	566.4	DAP76b	$*V_1N_3^-$	$s = 10$, calc. 2.200 eV	5.120b	[Naz92]
NL2070c	2.202	17.76	563.0	DAP1c	$*N_1^\circ + B_1^\circ$	$s = 16$, calc. 2.2202, obs. 2.20 eV		[Dea64c]
NL2205	2.205	17.79	562.3	...	...	NBD, var 2.205–2.218 eV	7.87b, 7.94b	[San94]
NL2100c	2.206	17.79	562.0	S1b-DAP43c	$*V_1N_1^\circ$	$s = 30$, calc. 2.205 eV	7.110	[Sob69c, Zai01]
NL2006e	2.207	17.80	561.7	DAP55e	$V_1N_3^\circ$(a)	$s = 162$, calc. 2.207 eV	5.93 = **7.99**	[Sob76]
NL2041c	2.215	17.87	559.7	DAP75c	$*(V_3Si_2)^-$	$s = 12$, calc. 2.211	7.118	[Gra94]
NL2095d	2.217	17.88	559.2	DAP19d	$*N_2^\circ + B_1^-$	NBD; $s = 12$ calc. 2.215	5.130, 7.132	[Per88, Moh82b]
NL2164c	2.227	17.96	556.7	DAP76c	$*V_1N_3^-$	$s = 12$, calc. 2.228 eV	5.120b	[Naz92]
NL2070d	2.240	18.07	553.5	DAP1d	$*N_1^\circ + B_1^\circ$	$s = 13$, calc. 2.239, obs. 2.24 eV		[Dea64c]
NL2164d	2.244	18.10	552.5	DAP76d	$*V_1N_3^-$	$s = 14$, calc. 2.250 eV	5.120b	[Naz92]
NL2095e	2.254	18.18	550.0	DAP19e	$*N_2^\circ + B_1^-$	NBD; $s = 10$ calc. 2.246 eV	5.130, 7.132	[Per94b, Moh82b]
NL2100d	2.263	18.25	547.8	S1b-DAP43d	$*V_1N_1^\circ$	$s = 50$, calc. 2.264 eV	7.110	[Sob69c, Zai01]
NL1743w	2.270	18.31	546.2	DAP9w	$*N_1^+ + B_1^\circ$	$s = 4$; calc. 2.270 eV	...	[Col82d]
NL2041d	2.280	18.39	543.8	DAP75d	$*(V_3Si_2)^-$	$s = 20$, calc. 2.281	7.118	[Gra94]

(continued)

Table 2.3.6.1 (continued)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. 3–6 [Zai01]; Fig. 7. [Zai98]	References
NL2070e	2.284	18.42	542.8	DAP1e	$*N_1{}^\circ + B_1{}^\circ$	$s = 10$, calc. 2.285 eV, obs. 2.26 eV	...	[Dea64c]
NL2297a	2.297	18.53	539.7	N3(a)	$V_1N_3{}^\circ$(a)	ZPL of DAP55(= NL2006z) and of N3(a) band (2.12eV), delayed luminescence, see Table 8.1.3.2	$5.93 = 7.99$	[Sob76]
NL2164e	2.306	18.60	537.6	DAP76e	$*V_1N_3{}^-$	$s = 22$, calc. 2.306 eV	5.120b	[Naz92]
NL2100e	2.312	18.65	536.2	S1b-DAP43e	$*V_1N_1{}^\circ$	$s = 86$, calc. 2.311 eV	7.110	[Sob69c, Zai01]
NL2070f	2.331	18.80	531.9	DAP1f	$*N_1{}^\circ + B_1{}^\circ$	$s = 8$, calc. 2.331, obs. 2.30	...	[Dea64c]
NL2041e	2.335	18.83	531.0	DAP75e	$*(V_3Si_2)^-$	$s = 34$, calc. 2.338	7.118	[Gra94]
NL2100f	2.337	18.85	530.5	S1b-DAP43f	$*V_1N_1{}^\circ$	$s = 130$, calc. 2.339 eV	7.110	[Sob69c, Zai01]
NL2164f	2.342	18.89	529.4	DAP76f	$*V_1N_3{}^-$	$s = 32$, calc. 2.344 eV	5.120b	[Naz92]
NL2095f	2.347	18.93	528.2	DAP19f	$*N_2{}^\circ + B_1{}^-$	NBD; $s = 6$ calc. 2.349	5.130, 7.132	[Per88, Moh82b]
NL2041f	2.357	19.01	526.0	DAP75f	$*(V_3Si_2)^-$	$s = 42$, calc. 2.355	7.118	[Gra94]
NL2164g	2.357	19.01	526.0	DAP76g	$*V_1N_3{}^-$	$s = 36$, calc. 2.355 eV	5.120b	[Naz92]

Table 2.3.6.2 Natural diamond: luminescence lines, visible: green, Part 2 (2.36–2.43 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. **3–6** [Zai01]; Fig. **7**. [Zai98]	References
NL2363	2.363	19.06	524.7	…	…	NBD, delayed (1 ms) luminescence	…	[Fie92]
NL2041g	2.368	19.10	523.6	DAP75f	*$(V_3Si_2)^-$	$s = 50$, calc. 2.371	**7**.118	[Gra94]
NL2370	2.370	19.11	523.3	**Ni-2.37-A**	*$V_1Ni_3^+$	ZPL of DAP92a–f, NL three lines b, c, e; others ML	**7**.103	[Ily71a]
NL2100g	2.372	19.13	522.7	S1b-DAP43g	*$V_1N_1^\circ$	$s = 228$, calc. 2.373 eV	**7**.110	[Sob69c, Zai01]
NL2070g	2.373	19.14	522.4	DAP1g	*$N_1^\circ + B_1^\circ$	$s = 7$, calc. 2.369 eV, obs.: 2.37 eV	…	[Dea64c]
NL2164h	2.377	19.17	521.6	DAP76h	*$V_1N_3^-$	$s = 48$, calc. 2.377 eV	**5**.120b	[Naz92]
NL2164i	2.382	19.21	520.5	DAP76i	*$V_1N_3^-$	$s = 50$, calc. 2.381 eV	**5**.120b	[Naz92]
NL2391	2.391	19.29	518.4	…	…	NBD, SBs at −29 and −47 meV	…	[Naz85a, Fie92]
NL2393a	2.393	19.30	518.1	**N3b**-DAP56a	$V_1N_3^\circ$ (b)	Four lines a–d(2.562 eV), delayed, $s = 16$, calc. 2.402	**5**.93 = **7**.99	[Sob76]
NL2164j	2.395	19.32	517.7	DAP76j	*$V_1N_3^-$	$s = 64$, calc. 2.397 eV	**5**.120b	[Naz92]
NL2095g	2.403	19.38	515.9	DAP19g	*$N_2^\circ + B_1^-$	NBD; $s = 4$, calc. 2.424, named yellow A line	**5**.130, **7**.132	[Per88, Moh82b]
NL2041h	2.410	19.44	514.4	DAP75h	*$(V_3Si_2)^-$	$s = 98$, calc. 2.414	**7**.118	[Gra94]
NL2070h	2.413	19.46	513.8	DAP1h	*$N_1^\circ + B_1^\circ$	$s = 6$, calc. 2.398 eV, obs.: 2.37 eV	…	[Dea64c]
NL2164k	2.420	19.52	512.3	DAP76k	*$V_1N_3^-$	$S = 98$, calc. 2.422 eV	**5**.120b	[Naz92]
NL2424	2.424	19.55	511.5	…	…	NBD…	…	[Zai01]
NL2429a	2.429	19.59	510.4	**S1a**	*$V_1N_1^\circ$	NBD, two lines a, b(2.463 eV), exc. st. spl., a = weak	**7**.110	[Sob69c, Zai01]
NL2393b	2.430	19.60	510.2	N3b-DAP56b	$V_1N_3^\circ$	$s = 22$, calc. 2.443	**5**.93 = **7**.99	[Sob76]

Table 2.3.7 Natural diamond: luminescence lines, visible: blue (2.43–2.58 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. 3–6 [Zai01]; Fig. 7. [Zai98]	References
NL2041i	2.437	19.66	508.7	DAP75i	$*(V_3Si_2)^-$	$s = 162$, calc. 2.438	7.118	[Gra94]
NL2440a	2.440	19.68	508.1	N3c-DAP24a	$V_1N_3^\circ$	Seventeen lines a–q(2.897 eV); $s = 4$, calc. 2.438 eV	...	[Dea65a]
NL2164-l	2.442	19.70	507.7	DAP76-l	$*V_1N_3^-$	$s = 162$, calc. 2.445 eV	5.120b	[Naz92]
NL2041j	2.450	19.76	506.0	DAP75j	$*(V_3Si_2)^-$	$s = 228$, calc. 2.452	7.118	[Gra94]
NL2070i	2.456	19.81	504.8	DAP1i	$*N_1^\circ + B_1^\circ$	$s = 5$, calc. 2.444 eV, obs.: 2.45 eV	...	[Dea64c]
NL2164m	2.457	19.82	504.6	DAP76m	$*V_1N_3^-$	$s = 228$, calc. 2.458 eV	5.120b	[Naz92]
NL2100z	2.463	19.87	503.4	S1b-DAP43z	$*V_1N_1^\circ$	NBD, ZPL of DAP43a–g, see Table 8.1.3.1	7.110	[Sob69c, Zai01]
NL2464	2.464	19.88	503.2	H3a	$V_1N_2^\circ$	var. 2.462–2.465; ZPL of DAP51a–f, see ML	...	[Zai01]
NL2476a	2.476	19.97	500.7	DAP74a	$*V_1B_1(b)$	Six lines a–f(2.966 eV), $s = 2$, calc. 2.467 eV	...	[Dea65a]
NL2095h	2.478	19.99	500.3	DAP19h	$*N_2^\circ + B_1^-$	NBD; $s = 3$, calc. 2.501, named yellow B line	5.130, 7.132	[Per88, Moh82b]
NL2490	2.490	20.08	497.9	...	...	NBD, 1 ms delay	7.134b	[Zai01]
NL2496a	2.496	20.13	496.7	S3-DAP58a	$*(V_2Ni_1)N_{2+0+0}$	Five lines a–e(2.652 eV, see MA), $s = 162$, calc. 2.494	7.63a	[Bok86]
NL2393c	2.500	20.17	495.9	N3b-DAP56c	$V_1N_3^\circ$	$s = 42$, calc. 2.502	5.93, 7.99	[Sob76]
NL2515	2.515	20.29	492.9	...	Si?	NBD	...	[Per94b]

NL	eV		nm	DAP	Defect	Notes	Fig.	Ref.
NL2520	2.520	20.33	492.0		B?	In IIb diamonds	**7.117**	[Wig71]
NL2523	2.523	20.35	491.4	DAP75z	$*(V_3Si_2)^-$	NBD, ZPL of DAP75a–j; QLVM(2Si): −44 meV	**7.118**	[Gra94]
NL2164z	2.526	20.38	490.8	DAP76z	$*V_1N_3^-$	ZPL of DAP76a–m; QLVM(3N + 1C): −46 meV	**5.120b**, **7.119**	[Naz92, Col82e]
NL2537a	2.537	20.46	488.7	**S2**-DAP57a	$(V_2Ni_1)\ N_{2+0+1}$	Nine lines a–i(4.938 eV); var. 2.527–2.537 eV, $s = 162$, calc. 2.533 eV, named S2-B line; SBs at −46 meV	**7.103**	[Ily71a]
NL2095i	2.550	20.57	486.2	DAP19i	$*N_2{}^\circ + B_1{}^-$	NBD; $s = 2$, calc. 2.543	**5.130**, **7.132**	[Per88, Moh82b]
NL2556	2.556	20.62	485.0	...	...	NBD, 1 ms delay	...	[Fie92]
NL2393d	2.562	20.67	483.9	N3b-DAP56d	$V_1N_3{}^\circ$	$s = 86$, calc. 2.556	**5.93** = **7.99**	[Sob76]
NL2565	2.565	20.69	483.3	...	...	NBD, rel. to 2.818 eV center?	...	[Per94b]
NL2070k	2.568	20.71	482.8	DAP1k	$*N_1{}^\circ + B_1{}^\circ$	$s = 3$; calc. 2.565 eV, obs.: 2.54 eV	...	[Dea64c]
NL2440b	2.580	20.81	480.5	N3c-DAP24b	$V_1N_3{}^\circ$	$s = 8$, calc. 2.578 eV; named D_8 [Dea65a, Dea65b]	**7.117a**, **7.141**	[Wig71, Cla65]

Table 2.3.8 Natural diamond: luminescence lines, visible: ultramarine (2.58–2.75 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. **3–6.** [Zai01]; Fig. **7.** [Zai98]	References
NL2476b	2.590	20.89	478.7	DAP74b	$*V_1B_1$ (b)	$s = 4$, calc. 2.586 eV	...	[Dea65a]
NL2440c	2.591	20.90	478.5	N3c-DAP24c	$V_1N_3^\circ$	$s = 9$, calc. 2.595 eV	7.141	[Cla65, Dea65a]
NL2537b	2.597	20.95	477.4	S2-DAP57b	(V_2Ni_1) N_{2+0+1}	$s = 64$, calc. 2.598 eV, named S2-C line	7.103	[Ily71a]
NL2070–l	2.623	21.16	472.7	DAP1-l	$*N_1^\circ + B_1^\circ$	$s = 2$, calc. 2.611 eV, obs. 2.57 eV	...	[Dea64c]
NL2095j	2.623	21.16	472.7	DAP19j	$*N_2^\circ + B_1^-$	NBD; $s = 1$ calc. 2.618	5.130, 7.132	[Per88, Moh82b]
NL2537c	2.623	21.16	472.7	**S2**-DAP57c	(V_2Ni_1) N_{2+0+1}	var. 2.618–2.627, $s = 50$, calc. 2.621 eV, S2-D line	7.103	[Ily71a]
NL2537d	2.634	21.25	470.7	**S2**-DAP57d	(V_2Ni_1) N_{2+0+1}	$s = 42$, calc. 2.640 eV, named S2-E line	7.103	[Ily71a]
NL2649a	2.649	21.37	468.0	DAP18a	$*N_2^+ + B_1^\circ$	NBD; eight lines a–h(3.204 eV), DAP18e–g see NA; $s = 18$, calc. 2.648 eV	5.137, 7.132	[Moh82b]
NL2440d	2.650	21.37	467.8	**N3c**-DAP24d	$V_1N_3^\circ$	$s = 12$, calc. 2.653 eV; named D$_7$ [Dea65a, Dea65b]	7.141a	[Cla65, Dea65a]
NL2652a	2.652	21.39	467.5	DAP22a	$*V_1N_3^+$	Thirteen lines a–m(3.296 eV), $s = 1$, calc. 2.652 eV	...	[Dea64c, Dea65a]
NL2070m	2.668	21.52	464.7	DAP1m	$*N_1^\circ + B_1^\circ$	$s = 1$, calc. 2.694 eV, obs. 2.60 eV	...	[Dea64c]
NL2440e	2.678	21.60	462.9	**N3c**-DAP24e	$V_1N_3^\circ$	$s = 14$, calc. 2.678 eV	7.117a, 7.141a	[Wig71], [Cla65]

						ZPL		
NL2393z	2.680	21.62	462.6	**N3b-**DAP56z	$V_1N_3{}^\circ$	ZPL of N3b-DAP56a–d, delayed	**5.93** = 7.99	[Sob76]
NL2681a	2.681	21.62	462.4	DAP66a	$*V_1Al_1{}^\circ$	Nine lines a–i(2.874 eV), $s = 22$, calc. 2.683 eV	**5.138a**, **7.140a**	[Per93]
NL2649b	2.699	21.77	459.3	DAP18b	$*N_2{}^+ + B_1{}^\circ$	NBD; $s = 14$, calc. 2.691 eV, named yellow D line	7.132	[Moh82b]
NL2476c	2.720	21.94	455.8	DAP74c	$*V_1B_1$ (b)	$s = 8$, calc. 2.722 eV	...	[Dea65a]
NL2649c	2.721	21.95	455.6	DAP18c	$*N_2{}^+ + B_1{}^\circ$	NBD; $s = 12$, calc. 2.719 eV, SBs with 34–37 meV	**5.129**, 7.132	[Col82d, Moh82b]
NL2681b	2.722	21.96	455.5	DAP66b	$*V_1Al_1{}^\circ$	$s = 30$, calc. 2.725 eV	**5.138a** = 7.140a	[Per93]
NL2725	2.725	21.98	455.0	...	...	...	...	[Wig71]
NL2652b	2.731	22.03	454.0	DAP22b	$*V_1N_3{}^+$	$s = 2$, calc. 2.731 eV	...	[Dea64c,Dea65a]
NL2681c	2.739	22.09	452.6	DAP66c	$*V_1Al_1{}^\circ$	$s = 34$, calc. 2.739 eV	**5.138a** = 7.140a	[Per93]
NL2440f	2.741	22.11	452.3	**N3c-**DAP24f	$V_1N_3{}^\circ$	$s = 22$, calc. 2.739 eV; named D_6 [Dea65a, Dea65b]	7.117a, 7.141a	[Wig71], [Cla65]
NL2649d	2.748	22.16	451.2	DAP18d	...	NBD; $s = 10$, calc. 2.756 eV, named yellow E line	7.132	[Moh82b]

Table 2.3.9.1 Natural diamond: luminescence lines, visible: violet, Part 1 (2.75–2.94 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. 3–6. [Zai01]; Fig. 7. [Zai98]	References
NL2681d	2.758	22.25	449.5	DAP66d	*V$_1$Al$_1$°	$s = 42$, calc. 2.760 eV	5.138a = 7.140a	[Per93]
NL2681e	2.779	22.42	446.1	DAP66e	*V$_1$Al$_1$°	$s = 50$, calc. 2.779 eV	5.138a = 7.140a	[Per93]
NL2440g	2.805	22.62	442.0	**N3c**-DAP24g	V$_1$N$_3$°	$s = 42$, calc. 2.807 eV; named D$_5$ [Dea65a, Dea65b]	7.141a	[Cla65, Dea65a]
NL2815	2.815	22.71	440.4	...	V?, N?	Paramagnetic	...	[Zai01]
NL2818	2.818	22.73	439.9	...	...	NBD	5.130 = 7.134a	[Per88]
NL2681f	2.823	22.73	439.9	DAP66f	*V$_1$Al$_1$°	$s = 86$, calc. 2.823 eV	5.138a = 7.140a	[Per93]
NL2440h	2.823	22.77	439.2	N3c-DAP24h	V$_1$N$_3$°	$s = 50$, calc. 2.823 eV; named D$_4$ [Dea65a, Dea65b]	7.141a	[Cla65, Dea65a]
NL2440i	2.827	22.80	438.5	N3c-DAP24i	V$_1$N$_3$°	$s = 54$, calc. 2.828 eV	7.117a, 7.141a	[Wig71, Cla65]
NL2833	2.833	22.85	437.6	...	...	Type II b,	...	[Dav77c]
NL2440j	2.834	22.86	437.5	N3c-DAP24j	V$_1$N$_3$°	$s = 58$, calc. 2.833 eV	7.141a	[Cla65, Dea65a]
NL2440k	2.836	22.88	437.2	N3c-DAP24k	V$_1$N$_3$°	$s = 62$, calc. 2.839 eV	Table 5.8	[Zai01] (p. 322)
NL2681g	2.836	22.88	437.2	DAP66g	*V$_1$Al$_1$°	$s = 106$, calc. 2.836 eV	5.138a = 7.140a	[Per93]

NL2440-l	2.841	22.92	436.4	N3c-DAP24-l	$V_1N_3{}^\circ$	$s = 64$, calc. 2.841 eV	Table 5.8	[Zai01] (p. 322)
NL2440m	2.853	23.01	434.6	N3c-DAP24m	$V_1N_3{}^\circ$	$s = 74$, calc. 2.851 eV	Table 5.8	[Zai01] (p. 322)
NL2652c	2.855	23.03	434.2	DAP22c	$*V_1N_3{}^+$	$s = 4$, calc. 2.855 eV	…	[Dea64c,Dea65a]
NL2440n	2.864	23.10	432.9	N3c-DAP24n	$V_1N_3{}^\circ$	$s = 86$, calc. 2.861 eV	Table 5.8	[Zai01] (p. 322)
NL2440-o	2.872	23.17	431.7	N3c-DAP24-o	$V_1N_3{}^\circ$	$s = 106$, calc. 2.873 eV; named D_3 [Dea65a, Dea65b]	7.141a	[Cla65, Dea65a]
NL2681i	2.874	23.18	431.4	DAP66i	$*V_1Al_1{}^\circ$	$s = 228$, calc. 2.877 eV	**5.138a** = **7.140a**	[Per93]
NL2476d	2.876	23.20	431.1	DAP74d	$*V_1B_1(b)$	$s = 22$, calc. 2.880 eV	…	[Dea65a]
NL2440p	2.889	23.30	429.1	N3c-DAP24p	$V_1N_3{}^\circ$	$s = 130$, calc. 2.884 eV	7.141a	[Cla65, Dea65a]
NL2440q	2.897	23.37	428.0	N3c-DAP24q	$V_1N_3{}^\circ$	$s = 162$, calc. 2.895 eV; named D_2 [Dea65a, Dea65b]	7.117a, 7.141a	[Wig71, Cla65]
NL2920	2.920	23.55	424.6	…	B?	…	…	[Zai01]
NL2985-s1	2.921	23.56	424.4	N3c-s1	$V_1N_3{}^\circ$	SB, -64 meV	Table 5.8	[Zai01] (p. 322)
NL2476e	2.930	23.63	423.1	DAP74e	$*V_1B_1(b)$	$s = 34$, calc. 2.928 eV	…	[Dea65a]
NL2985-s2	2.933	23.66	422.7	N3c-s2	$V_1N_3{}^\circ$	SB, -52 meV	Table 5.8	[Zai01] (p. 322)
NL2985-s3	2.938	23.70	422.0	N3c-s3	$V_1N_3{}^\circ$	SB, -47 meV	Table 5.8	[Zai01] (p. 322)

Table 2.3.9.2 Natural diamond: luminescence lines, visible: violet, Part 2 (2.94–3.10 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. **3–6.** [Zai01]; Fig. **7.** [Zai98]	References
NL2652d	2.940	23.71	421.7	DAP22d	*$V_1N_3^+$	$s = 6$, calc. 2.934 eV	…	[Dea64c,Dea65a]
NL2985-s4	2.942	23.73	421.4	N3c-s4	$V_1N_3^\circ$	SB, −43 meV; named D_1 [Dea65a, Dea65b]	Table 5.8	[Zai01] (p. 322)
NL2985-s5	2.949	23.79	420.4	N3c-s5	$V_1N_3^\circ$	SB, −36 meV	Table 5.8	[Zai01] (p. 322)
NL2681z = NL2964a	2.964	23.91	418.3	DAP66z	*$V_1Al_1^\circ$	Two lines a, b(2.974 eV); ZPL of DAP66a-i; line (a) dominant at $T < 50$ K, (b) at $T > 50$ K	**5.**138a = **7.**140a	[Per93]
NL2476f	2.966	23.92	418.0	DAP74f	*V_1B_1(b)	$s = 50$, calc. 2.962 eV	…	[Dea65a]
NL2964b	2.974	23.99	416.9	…	*$V_1Al_1^\circ$	Slow (delay 0.1–2.0 ms), similar DAP as DAP66	**5.**138a = **7.**140a	[Per93]
NL2985 = NL2440z	2.985	24.08	415.3	**N3c**	$V_1N_3^\circ$	ZPL of DAP24a-q(2.897 eV); 0.59 meV excited state splitting; named D_0 [Dea65a, Dea65b]	**7.**99, **7.**140b	[Sob76, Per93]
NL2652e	2.990	24.12	414.6	DAP22e	*$V_1N_3^+$	$s = 8$, calc. 2.998 eV	…	[Dea64c,Dea65a]
NL2652f	3.041	24.53	407.7	DAP22f	*$V_1N_3^+$	$s = 10$, calc. 3.041 eV	…	[Dea64c,Dea65a]
NL2652g	3.077	24.82	402.9	DAP22g	*$V_1N_3^+$	$s = 12$, calc. 3.074 eV	…	[Dea64c,Dea65a]

Table 2.3.10 Natural diamond: luminescence lines, near ultraviolet (3.10–3.94 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. 3–6 [Zai01]; Fig. 7. [Zai98]	References
NL2652h	3.120	25.17	397.4	DAP22h	$*V_1N_3^+$	$s=16$, calc. 3.120 eV	...	[Dea64c,Dea65a]
NL2476z	3.120	25.17	397.4	DAP74z	$*V_1B_1(b)$	ZPL of DAP74a–f	...	[Dea65a]
NL2652i	3.139	25.32	395.0	DAP22i	$*V_1N_3^+$	$s=18$, calc. 3.137 eV	...	[Dea64c,Dea65a]
NL2652j	3.165	25.53	391.7	DAP22j	$*V_1N_3^+$	$s=22$, calc. 3.162 eV	...	[Dea64c,Dea65a]
NL2649h	3.204	25.84	386.9	DAP18h	$*N_2^+ + B_1^\circ$	NBD; $s=1$ calc. 3.196, named yellow H line	7.132	[Moh82b]
NL2652k	3.213	25.92	385.9	DAP22k	$*V_1N_3^+$	$s=34$, calc. 3.213 eV	...	[Dea64c,Dea65a]
NL3224	3.216	25.94	385.5	**I-line**	...	NBD, closely related to $*N_2^+ + B_1^\circ$ – DAP18	7.132	[Moh82b]
NL3224	3.224	26.00	384.5	**J-line**	...	NBD, closely related to $*N_2^+ + B_1^\circ$ – DAP18	7.132	[Moh82b]
NL2652-l	3.246	26.18	381.9	DAP22-l	$*V_1N_3^+$	$s=50$, calc. 3.248 eV	...	[Dea64c,Dea65a]
NL2652m	3.296	26.59	376.1	DAP22m	$*V_1N_3^+$	$s=98$, calc. 3.296 eV	...	[Dea64c,Dea65a]
NL3414-s1	3.340	26.94	371.2	...	$*V_1N_3^+$	SB(QLVM:2N) −74 meV, dominant line	...	[Dea64c,Dea65a]
NL3414 = NL2652z	3.414	27.54	363.1	DAP22z	$*V_1N_3^+$	ZPL of DAP22a–m (2.652–3.296 eV), very weak line	...	[Dea64c,Dea65a]

Table 2.3.11.1 Natural diamond: luminescence lines, far ultraviolet, Part 1 (4.43–5.10 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. **3–6** [Zai01]; Fig. **7.** [Zai98]	References
NL5356a-s1	4.755	38.35	260.7	BE-B(a)-s1	B	SB −601 meV (= 142 + 3 × 153?); named **D**$_4$	**5.169** = **7.157**	[Dea65b]
NL4810a	4.810	38.80	257.7	**N9a**-DAP64a	*V$_1$N$_4$ $^-$	Nine lines a–i(5.165 eV), $s = 8$, calc. 4.814 eV	**7.161**	[Wig67]
NL5409a-s1	4.810	38.80	257.7	FE(a)-s1	...	SB −599 meV (= 4 × 150(TO)?), named **B**$_4$	**5.169** = **7.157**	[Dea65b]
NL4846a	4.846	39.09	255.8	**T-line**	...	Two lines a, b = T, T'(4.855 eV) in type IaB	...	[Dav77c]
NL4846b	4.855	39.16	255.4	T'-line	...	SB (LVM) at −148 meV	...	[Dav77c]
NL5356a-s2	4.890	39.44	253.5	BE-B(a)-s2	B	SB −466 meV (= 140 + 2 × 153?); named **D**$_3$	**5.152** = **7.159** **5.169** = **7.157**	[Dea65b]
NL5356b-s1	4.903	39.55	252.9	BE-B(b)-s1	B	SB 464 meV (= 140 + 2 × 152?); named **D**$_3'$	**5.152** = **7.159** **5.169** = **7.157**	[Dea65b]
NL5409a-s2	4.952	39.94	250.4	FE(a)-s2	...	SB −457 meV (= 3 × 152(TO)?), named B$_3$	**5.152** = **7.159** **5.169** = **7.157**	3× [Dea65b]
NL4810b	4.957	39.98	250.1	N9a-DAP64b	*V$_1$N$_4$ $^-$	$s = 18$, calc. 4.960 eV	**7.161**	[Wig67]
NL4810c	4.975	40.13	249.2	N9a-DAP64c	*V$_1$N$_4$ $^-$	$s = 20$, calc. 4.975 eV	**7.161**	[Wig67]

NL4986a	4.986	40.22	248.7	line N	…	Four lines a–d, named N, M, L, K(5.092 eV)	5.154	[Den92]
NL5409a-s3	4.990	40.25	248.5	FE(a)-s3	…	SB −419 meV (=87(TA)+2 × 166(LO)?), named A$_3$	5.152, 7.157, 5.155b	2× [Dea65b] [Ste96b,Ron99]
NL4986b	4.999	40.32	248.0	line M	…	Dominant line, 4 SBs (LVM) with −150 meV	5.154	[Den92]
NL5145-s1	5.005	40.37	247.7	*BE-Y	?	SB −140 meV (TO), named E$_1$	5.155b, 5.169	Ste96b, Dea65b
NL4810d	5.010	40.41	247.5	N9a-DAP64d	*V$_1$N$_4^-$	$s = 26$, calc. 5.009 eV	7.161	[Wig67]
NL5356a-s3	5.023	40.52	246.8	BE-B(a)-s3	B	SB −333 meV (= 2 × 166?); named D$_2''$	5.152	[Dea65b]
NL4986c	5.037	40.63	246.1	Lines L, L′	…	Split into 5.032 and 5.042 eV	5.154	[Den92]
NL4810e	5.040	40.65	246.0	N9a-DAP64e	*V$_1$N$_4^-$	$s = 34$, calc. 5.040 eV	7.161	[Wig67]
NL5356a-s4	5.048	40.72	245.6	BE-B(a)-s4	B	SB −308 meV (= 141 + 167?); named D$_2$	5.152, 7.159 5.169 = 7.157	3× [Dea65b]
NL5356b-s2	5.060	40.81	245.0	BE-B(b)-s2	B	SB −307 meV (= 141 + 166?); named D$_2'$	5.152, 7.159 5.169 = 7.157	3× [Dea65b]
NL4810f	5.089	41.06	243.6	N9a-DAP64f	*V$_1$N$_4^-$	$s = 58$, calc. 5.089 eV	7.161	[Wig67]
NL4986d	5.092	41.07	243.5	Line K	…	…	5.154	[Den92]
NL4810g	5.098	41.12	243.2	N9a-DAP64g	*V$_1$N$_4^-$	$s = 64$, calc. 5.098 eV	7.161	[Wig67]

Table 2.3.11.2 Natural diamond: luminescence lines, far ultraviolet, Part 2 (5.10–5.37 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. 3–6 [Zai01]; Fig. 7. [Zai98]	References
NL4810h	5.112	41.23	242.5	N9a-DAP64h	$*V_1N_4{}^-$	$s = 198$, calc. 5.165 eV	7.161	[Wig67]
NL5409a-s4	5.115	41.26	242.4	FE(a)-s4	…	SB -294 meV ($= 2 \times 147$(TO)?), named B_2	5.152, **7.159**	3× [Dea65b]
NL5409a-s5	5.151	41.55	240.7	FE(a)-s5	…	SB -258 meV (=87(TA)+171(LO)?), named A_2	5.169 = **7.157**; 5.155b	[Ste96b, Ron99]3×
NL4810i	5.165	41.66	240.0	N9a-DAP64i	$*V_1N_4{}^-$	$s = 198$, calc. 5.165 eV	7.161	[Wig67]
NL5356a-s5	5.193	41.89	238.7	BE-B(a)-s5	B	SB -163 meV; named $\mathbf{D_1}''$	5.152, **7.159**; 5.169 = **7.157**	[Dea65b]
NL5356a-s6	5.215	42.06	237.7	BE-B(a)-s6	B	SB -141 meV; named $\mathbf{D_1}$	5.152, **7.159**; 5.169 = **7.157**	[Dea65b]
NL5356b-s3	5.227	42.16	237.2	BE-B(b)-s3	B	SB -140 meV; named $\mathbf{D_1}'$	5.152, **7.159**; 5.169 = **7.157**	[Dea65b]
NL5409a-s6	5.246	42.31	236.3	FE(a)-s6	…	SB -163 meV (=LO); named C_1; very weak	5.152, **7.159**	[Dea65b]
NL5252a	5.252	42.36	236.1	**N9(a)**	$*V_1N_4{}^-$	ZPL of N9a-DAP64a-h; two lines a, b(5.262 eV)	7.161	[Wig67]

NL							
NL5409b-s1	5.253	42.37	236.0	FE(b)-s1	…	SB −163 meV (=LO); named C$_1$′; very weak	5.152, 7.159	[Dea65b]
NL5252b	5.262	42.44	235.6	N9(b)	*V$_1$N$_4$$^-$	ZPL	7.161	[Wig67]
NL5409a-s7	5.268	42.49	235.3	FE(a)-s7	…	SB −141 meV (=TO); named B$_1$	5.152, 7.159 \ 5.169 = 7.157 \ 5.155b	[Dea65b] \ [Ste96b, Ron99]
NL5409b-s2	5.275	42.55	235.0	FE(b)-s2	…	SB −141 meV (=TO); named B$_1$′	5.152, 7.159 \ 5.169 = 7.157 \ 5.155b	[Dea65b] \ [Ste96b, Ron99]
NL5409a-s8	5.322	42.93	233.0	FE(a)-s8	…	SB −87 meV (=TA); named A$_1$	5.152, 7.159	[Dea65b]
NL5409b-s3	5.329	42.98	232.6	FE(b)-s3	…	SB −87 meV (=TA); named A$_1$′	5.152, 7.159	[Dea65b]
NL5356a	5.356	43.20	231.5	BE-B(a)	B	NPL(upper VB); two lines a, b(5.367 eV), line D$_0$	7.159	[Dea65b]
NL5356b	5.367	43.29	231.0	BE-B(b)	B	NPL(lower VB), named line D$_0$′	7.159	[Dea65b]

Table 2.3.11.3 Natural diamond: luminescence lines, far ultraviolet, Part 3 (5.40–5.90 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. **3–6** [Zai01]; Fig. **7.** [Zai98]	References
NL5409a	5.409	43.63	229.2	FE(a)	…	NPL(upper VB); two energies a, b(5.416 eV), ***forbidden*** NPL of A$_{1-3}$(TA), B$_{1-4}$(TO), C$_1$(LO)	**7.**159	[Dea65b]
NL5409b	5.416	43.68	228.9	FE(b)	…	***Forbidden*** NPL(lower VB),	**7.**159	[Dea65b]
NL5409a–s9	5.436	43.85	228.1	FE(a)-s9	…	Antistokes SB (550 K) + 46 meV (= +87 − 41(temp. shift))	**7.**163	[Dea65b]
NL5409a–s10	5.490	44.28	225.8	FE(a)-s10	…	Antistokes SB (550 K) + 81 meV (= +141 − 60(temp. shift))	**7.**163	[Dea65b]

2.4   Broad Bands (NB)

Table 2.4.1 Natural diamond: broad bands, mid and near infrared (0.40–1.77 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./ defect	Comment	Figs. 3–6 [Zai01]; Fig. 7. [Zai98]	References
NB0399a	0.3986	3.215	3110	3LP(a)	...	**A**; three lattice phonons, var. 0.396–0.399 eV; 2 bands a, b(0.4500); $w = 23\%$; abs. coeff. $= 1.7$–3.0 cm^{-1}	**3.7, 3.8, 7.10**	[Zai01]
NB0399b	0.4500	3.630	2755	3LP(b)	...	**A**; three lattice phonons; var. 0.444–0.450 eV; $w = 8\%$; abs. coeff. $= 1.7$–3.0 cm^{-1}	7.170, 7.171 **3.7, 3.8, 7.10** 7.170, 7.171	[Zai01]
NB0659	0.6590	5.315	1881	...	B	**A**; $w = 22\%$	7.25	[Bok86]
NB1250	1.250	10.08	992.0	...	...	**CL, PL**; related to platelets; $w = 24\%$	5.9, 7.53	[Ruo91a]
NB1300	1.300	10.49	953.7	IR C band	...	**CL**; $w = 17\%$; ZPL at 1.673 eV; 11 SBs with 53–40 meV	**5.29 = 7.55**, 7.117	[Wig71, Rei98]
NB1719	1.719	13.87	721.2	...	...	**A**; in hydrogen rich nat. diam. $w = 14\%$	7.89	

Observation: A absorption, *CL, EL, IL, PL, XL* luminescence, *PLE* photoluminescence excitation

Table 2.4.2 Natural diamond: broad bands, visible: purple to violet (1.77–3.10 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. **3–6** [Zai01]; Fig. **7.** [Zai98]	References
NB1800	1.800	14.52	688.8	B band, DAP9	*$N_1^+ + B_1^\circ$	**A, CL, PL**; $w = 20\%$; structure of 20 lines (1.743–2.138 eV, see DAP9=NA/NL1743);	5.29, **5.137**	[Wig71, Rei98]
NB1805	1.805	14.56	686.9	Red band	...	**CL, PL**; $w = 17\%$; ZPL at 2.145 eV, 10 SBs with 30–35 meV	**7.92a**	[San90]
NB1900	1.900	15.33	652.5	Yellow1 band	...	**CL**; $w = 12\%$; ZPL at 2.051, eight SBs with 32 meV	**7.132**	[Moh82b]
NB1980	1.980	15.97	626.1	...	...	**PL**; $w = 9\%$	**7.94a**	[Orl73a, Bok86]
NB2000	2.000	16.13	619.9	...	...	A; $w = 12\%$, NBD	...	[Rei98]
NB2070	2.070	16.70	598.9	vis. C band	...	A; $w = 15\%$; ZPL at 1.673 eV; SBs 26 meV	**5.137**	
NB2100	2.100	16.94	590.4	A1 band	...	**XL**; $w = 30\%$; in type IIb diamonds; see A$_{semic}$(a) Table 10.2.2	...	[Dea65a]
NB2138	2.150	17.34	576.6	N3(a) band	$V_1N_3^\circ$	**CL, PL**(slow); ZPL at 2.297; $w = 17\%$; DAP55a–e; A$_{insul}$(a) band (Table 10.2.2)	**5.93** = 7.99	[Sob76, Dea65a]
NB2170	2.170	17.50	571.3	...	...	**CL, PL**; $w = 22\%$; related to H3 and large platelets	**7.91**	[Col82d, Bok86]
NB2200	2.200	17.75	563.5	DAP73 band	$V_1B_1^\circ$(a)	**CL, PL**(slow); $w = 23\%$, ZPL at 2.490 eV; type IIb, A$_{semic}$(b) band (Table 10.2.2)	**7.134b**	[Per88]
NB2230	2.230	17.99	556.0	...	...	A; $w = 16\%$	...	[Dav77c]

NB#	eV	$10^3\,cm^{-1}$	nm	Band	Defect	Observation	Fig.	References
NB2250	2.250	18.15	551.0	…	…	A; $w = 15\%$; gray, pink, violet H rich diamonds	**5.87**; **7.89**	[Col97,Fri91a]
NB2350	2.350	18.96	527.6	"Green"–band	$*N_2^\circ + B_1^-$	**CL**, **PL**; NBD; $w = 20\%$; DAP19a–j	5.130, 7.132	[Per88,Moh82b]
NB2440	2.440	19.68	508.1	…	…	**PL**; NBD, ZPL at 2.818	5.130 = 7.134a	[Per88]
NB2450	2.450	19.76	506.0	**N3(b)** band	$V_1N_3^\circ(b)$	**CL**, **PL**(slow); ZPL at 2.680 eV; $w = 21\%$; DAP56a–d; $A_{insul}(b)$ band (Table 10.2.2)	5.93 = 7.99	[Sob76,Dea65a]
NB2570	2.570	20.73	482.4	…	…	A, **PLE**; $w = 11\%$; ZPL at 2.145 eV, SBs with 23 meV	7.92b, 7.125	[San90,Col82d]
NB2740	2.740	22.10	452.5	DAP66 band	$*V_1Al_1^\circ$	**PL**; $w = 11\%$; NBD; ZPL at 2.964 and 2.974 eV	5.138a, 7.140a	[Per93]
NB2750	2.750	22.18	450.8	N3(c) band	$V_1N_3^\circ$	**PL**; ZPL at 2.985 eV, $w = 13\%$; DAP24a–q; $A_{insul}(c)$ band (Table 10.2.2)	7.117b, 7.141	[Wig71,Cla65, Dea65a]
NB2800	2.800	22.58	442.8	DAP74 band	$V_1B_1^\circ(b)$	**CL**; $w = 12\%$; type IIb; $A_{semic}(d)$ band (Table 10.2.2)	7.117a	[Dea65a]
NB2910	2.910	23.47	426.0	…	$*N_2^+ + B_1^\circ$	**CL**; NBD; $w = 16\%$; DAP18a–h	7.132	[Moh82b]
NB3000	3.000	24.20	413.3	DAP22–band	$*V_1N_3^+$	**CL**, **PL**; $w = 20\%$; $A_{insul}(d)$ band (Table 10.2.2)	…	[Dea64c,Dea65a]

Observation: *A* absorption, *CL, EL, IL, PL, XL* luminescence, *PLE* photoluminescence excitation

Table 2.4.3 Natural diamond: broad bands, near and far ultraviolet (3.10–5.90 eV)

Line-label	Energy (eV)	Frequ. (10^3 cm^{-1})	Wavel. (nm)	Name	Impur./defect	Comment	Figs. 3–6 [Zai01]; Fig. 7. [Zai98]	References
NB3180	3.180	25.65	390.0	...	...	A, PLE of yellow two band; NBD; w = 17%; ZPL at 2.721 eV	6.2	[Wel94, Per88]
NB3263	3.263	26.32	380.0	N3(c) band	$V_1N_3^\circ$(c)	CL, PL(slow), PLE; ZPL (DAP23) at 2.985 eV	5.93 = 7.99, 6.4	[Sob76, Zai01]
NB3300	3.300	26.62	375.7	...	N?	A; polarized E perpendicular to {1 1 1}	...	[Kop86]
NB3300	3.308	26.62	375.7	...	...	CL, PL, XL; w = 12% A$_{insnl}$(e) band (Table 10.2.2)	...	[Dea65a]
NB3750	3.750	30.25	330.6	...	...	PLE of 2.35-eV band; w = 12%; ZPL at 2.818 eV	5.130b, 7.134a	[Per94b, Per88]
NB3800	3.800	30.65	326.3	...	*$V_1Al_1^\circ$	PLE of 2.74-eV band (DAP66); NBD; w = 12%; var. 3.75–3.90 eV; ZPL at 2.964 and 2.974 eV	5.138b, 7.140b	[Per93]
NB4430	4.430	35.73	279.9	...	...	A; weak, related to platelets?	...	[Zai01]
NB4590	4.590	37.02	270.1	...	...	A; related to platelets?	...	[Dav94a, Sob68d]
NB4600	4.600	37.10	269.5	...	N?	A; w = 12%	7.154	[Dav94a, Sob68d]
NB4690	4.690	37.83	264.3	...	...	A, PL; weak	...	[Bok86, Sob68d]
NB5480	5.480	44.20	226.2	Indirect bandgap	...	A; begin of indirect bandgap absorption	5.160, 5.161	[Zai01, Col97]
NB5370	5.370	43.31	230.9	N9-DAP63 band	*$V_1N_4^-$	A, PLE of N9, N3(c) and other A bands; w = 5%; ZPL at 5.252 eV	5.158	[Col97, Den67, Dea64c]
NB5500	5.500	44.36	225.4	DAP21 band	...	PLE of N3(c) and other A bands; w = 8%	5.140	[Iak00a, Dea64c]
NB7120	7.120	57.43	174.1	Direct bandgap	...	A; begin of direct bandgap absorption	5.160	[Zai01]

Observation: *A* absorption, *CL, EL, IL, PL, XL* luminescence, *PLE* photoluminescence excitation