

Kinetic Scheme 11/6/2021

Category	Reaction Number	Collision	Rate Coefficient	Reference
e-He	1	$e + \text{He}^+ \Rightarrow \text{He}$	$2.7 \times 10^{-13} (\text{T}_{\text{e}} \text{k}_{\text{B}} / e)^{-3/4}$	[1]
	2	$2e + \text{He}^+ \Rightarrow \text{He}(2^1\text{P}) + e$	$1.1 \times 10^{-14} \text{T}_{\text{e}}^{-4.5} \text{T}_{\text{g}}^{2.3}$	[1]
	3	$2e + \text{He}^+ \Rightarrow \text{He}(2^3\text{P}) + e$	$1.1 \times 10^{-14} \text{T}_{\text{e}}^{-4.5} \text{T}_{\text{g}}^{2.3}$	[1]
	4	$2e + \text{He}^+ \Rightarrow \text{He}(2^1\text{S}) + e$	$1.1 \times 10^{-14} \text{T}_{\text{e}}^{-4.5} \text{T}_{\text{g}}^{2.3}$	[1]
	5	$2e + \text{He}^+ \Rightarrow \text{He}(2^3\text{S}) + e$	$1.1 \times 10^{-14} \text{T}_{\text{e}}^{-4.5} \text{T}_{\text{g}}^{2.3}$	[1]
	6	$e + \text{He} \Rightarrow \text{He}(2^3\text{S}) + e$	BOLSIG+	[2]
	7	$e + \text{He} \Rightarrow \text{He}(2^1\text{S}) + e$	BOLSIG+	[2]
	8	$e + \text{He} \Rightarrow \text{He}(2^3\text{P}) + e$	BOLSIG+	[2]
	9	$e + \text{He} \Rightarrow \text{He}(2^1\text{P}) + e$	BOLSIG+	[2]
	10	$e + \text{He} \Rightarrow \text{He}(3^3\text{S}) + e$	BOLSIG+	[2]
	11	$e + \text{He} \Rightarrow \text{He}(3^1\text{S}) + e$	BOLSIG+	[2]
	12	$e + \text{He} \Rightarrow \text{He}(3^3\text{P}) + e$	BOLSIG+	[2]
	13	$e + \text{He} \Rightarrow \text{He}(3^3\text{D}) + e$	BOLSIG+	[2]
	14	$e + \text{He} \Rightarrow \text{He}(3^1\text{P}) + e$	BOLSIG+	[2]
	15	$e + \text{He} \Rightarrow \text{He}(3^1\text{D}) + e$	BOLSIG+	[2]
	16	$e + \text{He} \Rightarrow \text{He}(4^3\text{S}) + e$	BOLSIG+	[2]
	17	$e + \text{He} \Rightarrow \text{He}(4^1\text{S}) + e$	BOLSIG+	[2]
	18	$e + \text{He} \Rightarrow \text{He}(4^3\text{P}) + e$	BOLSIG+	[2]
	19	$e + \text{He} \Rightarrow \text{He}(4^1\text{D}) + e$	BOLSIG+	[2]
	20	$e + \text{He} \Rightarrow \text{He}(4^3\text{D}) + e$	BOLSIG+	[2]
	21	$e + \text{He} \Rightarrow \text{He}(4^1\text{F}) + e$	BOLSIG+	[2]
	22	$e + \text{He} \Rightarrow \text{He}(4^3\text{F}) + e$	BOLSIG+	[2]
	23	$e + \text{He} \Rightarrow \text{He}(4^1\text{P}) + e$	BOLSIG+	[2]
	24	$e + \text{He} \Rightarrow \text{He}^+ + 2e$	BOLSIG+	[2]
	25	$e + \text{He}(2^1\text{P}) \Rightarrow \text{He}^+ + 2e$	$1.28 \times 10^{-7} (\text{T}_{\text{e}} \text{k}_{\text{B}} / e)^{0.6} \exp(-4.78 / (\text{T}_{\text{e}} \text{k}_{\text{B}} / e))$	[1]
	26	$e + \text{He}(2^3\text{P}) \Rightarrow \text{He}^+ + 2e$	$1.28 \times 10^{-7} (\text{T}_{\text{e}} \text{k}_{\text{B}} / e)^{0.6} \exp(-4.78 / (\text{T}_{\text{e}} \text{k}_{\text{B}} / e))$	[1]
	27	$e + \text{He}(2^1\text{S}) \Rightarrow \text{He}^+ + 2e$	$1.28 \times 10^{-7} (\text{T}_{\text{e}} \text{k}_{\text{B}} / e)^{0.6} \exp(-4.78 / (\text{T}_{\text{e}} \text{k}_{\text{B}} / e))$	[1]
	28	$e + \text{He}(2^3\text{S}) \Rightarrow \text{He}^+ + 2e$	$1.28 \times 10^{-7} (\text{T}_{\text{e}} \text{k}_{\text{B}} / e)^{0.6} \exp(-4.78 / (\text{T}_{\text{e}} \text{k}_{\text{B}} / e))$	[1]
	29	$e + \text{He}(2^1\text{P}) \Rightarrow \text{He}(2^3\text{P}) + e$	$1.8 \times 10^{-7} (1 + 0.47 (\text{T}_{\text{e}} \text{k}_{\text{B}} / e))^{-1}$	[1]
	30	$e + \text{He}(2^1\text{P}) \Rightarrow \text{He}(2^1\text{S}) + e$	$3.7 \times 10^{-7} (1 + 0.37 (\text{T}_{\text{e}} \text{k}_{\text{B}} / e))^{-1}$	[1]
	31	$e + \text{He}(2^1\text{P}) \Rightarrow \text{He}(2^3\text{S}) + e$	$3.1 \times 10^{-8} (1 + 0.13 (\text{T}_{\text{e}} \text{k}_{\text{B}} / e)^2)^{-1}$	[1]
	32	$e + \text{He}(2^1\text{P}) \Rightarrow \text{He} + e$	5×10^{-10}	[1]
	33	$e + \text{He}(2^3\text{P}) \Rightarrow \text{He}(2^1\text{S}) + e$	$3.1 \times 10^{-8} (1 + 0.94 (\text{T}_{\text{e}} \text{k}_{\text{B}} / e))^{-1}$	[1]
	34	$e + \text{He}(2^3\text{P}) \Rightarrow \text{He}(2^3\text{S}) + e$	$2.2 \times 10^{-7} (\text{T}_{\text{e}} \text{k}_{\text{B}} / e)^{1/3}$	[1]
	35	$e + \text{He}(2^3\text{P}) \Rightarrow \text{He} + e$	2.4×10^{-10}	[1]
	36	$e + \text{He}(2^1\text{S}) \Rightarrow \text{He}(2^3\text{S}) + e$	$3.8 \times 10^{-7} (1 + \text{T}_{\text{e}} \text{k}_{\text{B}} / e)^{-1}$	[1]
	37	$e + \text{He}(2^1\text{S}) \Rightarrow \text{He} + e$	3×10^{-9}	[1]
	38	$e + \text{He}(2^3\text{S}) \Rightarrow \text{He} + e$	$4.1 \times 10^{-9} (1 + \text{T}_{\text{e}} \text{k}_{\text{B}} / e)^{-1}$	[1]
	39	$e + \text{He}_2^+ \Rightarrow \text{He}(2^1\text{P}) + \text{He}$	$8.9 \times 10^{-9} (\text{T}_{\text{g}} / \text{T}_{\text{e}})^{1.5}$	[1]
	40	$e + \text{He}_2^+ \Rightarrow \text{He}(2^3\text{P}) + \text{He}$	$8.9 \times 10^{-9} (\text{T}_{\text{g}} / \text{T}_{\text{e}})^{1.5}$	[1]
	41	$e + \text{He}_2^+ \Rightarrow \text{He}(2^1\text{S}) + \text{He}$	$8.9 \times 10^{-9} (\text{T}_{\text{g}} / \text{T}_{\text{e}})^{1.5}$	[1]
	42	$e + \text{He}_2^+ \Rightarrow \text{He}(2^3\text{S}) + \text{He}$	$8.9 \times 10^{-9} (\text{T}_{\text{g}} / \text{T}_{\text{e}})^{1.5}$	[1]
	43	$e + \text{He} + \text{He}_2^+ \Rightarrow \text{He}(2^1\text{P}) + 2\text{He}$	$10^{-26} (\text{T}_{\text{g}} / \text{T}_{\text{e}})^2$	[1]
	44	$e + \text{He} + \text{He}_2^+ \Rightarrow \text{He}(2^3\text{P}) + 2\text{He}$	$10^{-26} (\text{T}_{\text{g}} / \text{T}_{\text{e}})^2$	[1]
	45	$e + \text{He} + \text{He}_2^+ \Rightarrow \text{He}(2^3\text{S}) + 2\text{He}$	$10^{-26} (\text{T}_{\text{g}} / \text{T}_{\text{e}})^2$	[1]
e-H	46	$2e + \text{H}^+ \Rightarrow \text{H} + e$	$10^{-19} (\text{T}_{\text{g}} / \text{T}_{\text{e}})^{4.5}$	[3]
e-H ₂	47	$e + \text{H}_2^+ \Rightarrow 2\text{H}$	$1.86 \times 10^{-7} / \text{T}_{\text{e}}^{0.43}$	[3]
	48	$2e + \text{H}_2^+ \Rightarrow \text{H}_2 + e$	$10^{-19} (\text{T}_{\text{g}} / \text{T}_{\text{e}})^{4.5}$	[3]
	49	$e + \text{H}_2 \Rightarrow 2\text{H} + e$	$3.29 \times 10^{-9} (1.5 \text{T}_{\text{e}} \text{k}_{\text{B}} / e)^{0.578} \exp(-7.56 / (1.5 \text{T}_{\text{e}} \text{k}_{\text{B}} / e))$	[3]

	50	$e + H_2 \Rightarrow H_2^+ + 2e$	$4 \times 10^{-11} (1.5T_{eK_B}/e)^{2.13} \exp(-14.9/(1.5T_{eK_B}/e))$	[3]
e-N	51	$e + N^+ + M \Rightarrow N + M$	$3.12 \times 10^{-23}/T_e^{1.5}$	[3]
	52	$2e + N^+ \Rightarrow N + e$	$10^{-19}(T_g/T_e)^{4.5}$	[3]
	53	$e + N \Rightarrow N^+ + 2e$	$1.45 \times 10^{-11} \times (1.5T_{eK_B}/e)^{2.58} \exp(-8.54/(1.5T_{eK_B}/e))$	[3]
e-N ₂	54	$e + N_2^+ \Rightarrow 2N$	$2.8 \times 10^{-7}(300/T_e)^{0.5}$	[4]
	55	$e + N_2^+ \Rightarrow N_2^+(B^2\Sigma_u^+v_0) + e$	$0.8765807 + 2.8182/(1 + (T_{eK_B}/e/5.78903)^{2.997126}) \times 100 \times (2T_{eK_B}/me)^{0.5}$	[5]*
	56	$e + N_2^+ + M \Rightarrow N_2 + M$	$3.12 \times 10^{-23}/T_e^{1.5}$	[3]
	57	$2e + N_2^+ \Rightarrow N_2 + e$	$10^{-19}(T_g/T_e)^{4.5}$	[3]
	58	$e + N_2 \Rightarrow N_2^+ + 2e$	BOLSIG+	[2]
	59	$e + N_2 \Rightarrow N_2(B^3\Pi_gv_0) + e$	BOLSIG+	[2]
	60	$e + N_2 \Rightarrow N_2(B^3\Pi_gv_1) + e$	BOLSIG+	[2]
	61	$e + N_2 \Rightarrow N_2(B^3\Pi_gv_2) + e$	BOLSIG+	[2]
	62	$e + N_2 \Rightarrow N_2(B^3\Pi_gv_3) + e$	BOLSIG+	[2]
	63	$e + N_2 \Rightarrow N_2(B^3\Pi_gv_4) + e$	BOLSIG+	[2]
	64	$e + N_2 \Rightarrow N_2(C^3\Pi_{uv}v_0) + e$	BOLSIG+	[2]
	65	$e + N_2 \Rightarrow N_2(C^3\Pi_{uv}v_1) + e$	BOLSIG+	[2]
	66	$e + N_2 \Rightarrow N_2(C^3\Pi_{uv}v_2) + e$	BOLSIG+	[2]
e-O	67	$e + O \Rightarrow O + e + hv(777.4nm)$	$10^7 \exp(-75.42 - 1.44(T_{eK_B}/e) \ln(T_{eK_B}/e) + 9(T_{eK_B}/e)^{0.5} \ln(T_{eK_B}/e)) \times 100 \times (2T_{eK_B}/me)^{0.5}$	[6]
	68	$e + O^+ + M \Rightarrow O + M$	$3.12 \times 10^{-23}/T_e^{1.5}$	[3]
	69	$2e + O^+ \Rightarrow O + e$	$10^{-19}(T_g/T_e)^{4.5}$	[3]
	70	$e + O \Rightarrow O^+ + 2e$	$4.75 \times 10^{-9}(1.5T_{eK_B}/e)^{0.61} \exp(-22.1/(1.5T_{eK_B}/e))$	[3]
	71	$e + O + O_2 \Rightarrow O^- + O_2$	10^{-31}	[3]
	72	$e + O + O_2 \Rightarrow O + O_2^-$	10^{-31}	[3]
e-O ₂	73	$e + O_2^+ \Rightarrow 2O$	$2 \times 10^{-7} \times (300/T_e)$	[4]
	74	$2e + O_2^+ \Rightarrow O_2 + e$	$10^{-19}(T_g/T_e)^{4.5}$	[3]
	75	$e + O_2^+ + M \Rightarrow O_2 + M$	$3.12 \times 10^{-23}/T_e^{1.5}$	[3]
	76	$e + O_2 \Rightarrow O^- + O$	BOLSIG+	[2]
	77	$e + O_2 \Rightarrow O_2^+ + 2e$	BOLSIG+	[2]
	78	$e + 2O_2 \Rightarrow O_2^- + O_2$	$1.4 \times 10^{-29} T_g/T_e \exp(-600/T_g) \exp(700(T_e - T_g)/(T_e T_g))$	[3]
	79	$e + O_2 + N_2 \Rightarrow O_2^- + N_2$	$1.4 \times 10^{-31} (T_g/T_e)^2 \exp(-70/T_g) \exp(1500(T_e - T_g)/(T_e T_g))$	[3]
e-O ₃	80	$e + O_3 \Rightarrow O_2^- + O$	10^{-9}	[4]
	81	$e + O_3 \Rightarrow O^- + O_2$	10^{-11}	[3]
	82	$e + O_3 \Rightarrow O + O_2 + e$	$1.78 \times 10^{-6} (1.5T_{eK_B}/e)^{-0.614} \exp(-11.5/(1.5T_{eK_B}/e))$	[3]
	83	$e + O_3 + M \Rightarrow O_3^- + M$	10^{-31}	[3]
e-H ₂ O	84	$e + H_2O^+ \Rightarrow O + 2H$	$1.37 \times 10^{-6}/T_e^{0.5}$	[3]
	85	$e + H_2O^+ \Rightarrow O + H_2$	$1.37 \times 10^{-6}/T_e^{0.5}$	[3]
	86	$e + H_2O^+ \Rightarrow OH + H$	$2.73 \times 10^{-6}/T_e^{0.5}$	[3]
	87	$2e + H_2O^+ \Rightarrow H_2O + e$	$10^{-19}(T_g/T_e)^{4.5}$	[3]
	88	$e + H_2O \Rightarrow H_2O^+ + 2e$	$9.65 \times 10^{-18} (1.5T_{eK_B}/e)^{2.53} \exp(-8.99/(1.5T_{eK_B}/e))$	[3]
	89	$e + H_2O \Rightarrow H_2 + O^-$	$2.97 \times 10^{-15} (1.5T_{eK_B}/e)^{-1.56} \exp(-13.67/(1.5T_{eK_B}/e))$	[3]
	90	$e + H_2O \Rightarrow OH + H^-$	$4.42 \times 10^{-14} (1.5T_{eK_B}/e)^{-2.0} \exp(-13.39/(1.5T_{eK_B}/e))$	[3]
	91	$e + H_2O \Rightarrow OH^+ + H + 2e$	$9.89 \times 10^{-6} (1.5T_{eK_B}/e)^{-1.64} \exp(-67.6/(1.5T_{eK_B}/e))$	[3]
	92	$e + H_2O \Rightarrow H^+ + OH + 2e$	$7.45 \times 10^{-9} (1.5T_{eK_B}/e)^{0.34} \exp(-54.2/(1.5T_{eK_B}/e))$	[3]
	93	$e + H_2O \Rightarrow O^+ + H_2 + 2e$	$7.4 \times 10^{-10} (1.5T_{eK_B}/e)^{0.45} \exp(-55.5/(1.5T_{eK_B}/e))$	[3]
	94	$e + H_2O \Rightarrow H_2^+ + O + 2e$	$8.49 \times 10^{-9} (1.5T_{eK_B}/e)^{-1.23} \exp(-74/(1.5T_{eK_B}/e))$	[3]
	95	$e + H_2O \Rightarrow OH + H + e$	$5.15 \times 10^{-9} (1.5T_{eK_B}/e)^{0.62} \exp(-10.9/(1.5T_{eK_B}/e))$	[3]
	96	$e + H_2O \Rightarrow OH^- + H$	$9.6 \times 10^{-10} (1.5T_{eK_B}/e)^{-1.7} \exp(-13.31/(1.5T_{eK_B}/e))$	[3]
e-OH	97	$e + OH \Rightarrow OH(A^2\Sigma^+v_0) + e$	$1.17 \times 10^{-8} T_e^{0.52} \exp(-44642.8/T_e)$	[7]
	98	$2e + OH^+ \Rightarrow OH + e$	$10^{-19}(T_g/T_e)^{4.5}$	[3]

e-NO	99	$e + NO^+ \Rightarrow N + O$	$1.07 \times 10^{-5}/T_e^{0.85}$	[3]
	100	$e + NO^+ + M \Rightarrow NO + M$	$3.12 \times 10^{-23}/T_e^{1.5}$	[3]
	101	$2e + NO^+ \Rightarrow NO + e$	$10^{-19}(T_g/T_e)^{4.5}$	[3]
	102	$e + NO + M \Rightarrow NO^- + M$	8×10^{-31}	[3]
e-NO ₂	103	$e + NO_2^+ \Rightarrow NO + O$	$3.46 \times 10^{-6}/T_e^{0.5}$	[3]
	104	$e + NO_2 + M \Rightarrow NO_2^- + M$	1.5×10^{-30}	[3]
	105	$e + NO_2 \Rightarrow O^- + NO$	10^{-11}	[3]
e-N ₂ O	106	$e + N_2O^+ \Rightarrow N_2 + O$	$3.46 \times 10^{-6}/T_e^{0.5}$	[3]
	107	$e + N_2O \Rightarrow O^- + N_2$	2×10^{-10}	[3]
e-HNO ₃	108	$e + HNO_3 \Rightarrow NO_2^- + OH$	5×10^{-8}	[3]
H ⁺	109	$H^+ + H^- \Rightarrow 2H$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	110	$H^+ + H_2 \Rightarrow H^+ + H_2$	6.4×10^{-10}	[3]
	111	$H^+ + O \Rightarrow O^+ + H$	3.8×10^{-10}	[3]
	112	$H^+ + O^- \Rightarrow O + H$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	113	$H^+ + OH^- \Rightarrow OH + H$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	114	$H^+ + H_2O \Rightarrow H_2O^+ + H$	8.2×10^{-9}	[3]
	115	$H^+ + NO \Rightarrow NO^+ + H$	1.9×10^{-9}	[3]
	116	$H^+ + NO^- \Rightarrow NO + H$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	117	$H^+ + O_2 \Rightarrow O_2^+ + H$	1.17×10^{-9}	[3]
	118	$H^+ + O_2^- \Rightarrow O_2 + H$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	119	$H^+ + N_2O^- \Rightarrow N_2O + H$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	120	$H^+ + NO_2^- \Rightarrow NO_2 + H$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	121	$H^+ + O_3^- \Rightarrow O_3 + H$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	122	$H^+ + NO_3^- \Rightarrow NO_3 + H$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
H	123	$H + H^- \Rightarrow H_2 + e$	1.8×10^{-9}	[3]
	124	$H + O^+ \Rightarrow H^+ + O$	6.8×10^{-10}	[3]
	125	$H + O + M \Rightarrow OH + M$	1.62×10^{-32}	[3]
	126	$H + OH + M \Rightarrow H_2O + M$	$6.1 \times 10^{-26}/T_g^2$	[3]
	127	$H + OH^- \Rightarrow H_2O + e$	1.8×10^{-9}	[3]
	128	$H + NO + M \Rightarrow HNO + M$	$10^{-32}\exp(300/T_g)$	[3]
	129	$H + O_2 + M \Rightarrow HO_2 + M$	$5.4 \times 10^{-32}(T_g/300)^{-1.8}$	[3]
	130	$H + O_2^- \Rightarrow HO_2 + e$	1.4×10^{-9}	[3]
	131	$2H + M \Rightarrow H_2 + M$	$1.8 \times 10^{-30}/T_g$	[3]
	132	$H + HNO \Rightarrow NO + H_2$	$3 \times 10^{-11}\exp(-500/T_g)$	[3]
	133	$H + HO_2 \Rightarrow H_2 + O_2$	5.6×10^{-12}	[3]
	134	$H + HO_2 \Rightarrow O + H_2O$	2.4×10^{-12}	[3]
	135	$H + HO_2 \Rightarrow 2OH$	$4.2 \times 10^{-10}\exp(-950/T_g)$	[3]
	136	$H + H_2O_2 \Rightarrow OH + H_2O$	$1.69 \times 10^{-11}\exp(-1800/T_g)$	[3]
	137	$H + H_2O_2 \Rightarrow HO_2 + H_2$	$2.8 \times 10^{-12}\exp(-1900/T_g)$	[3]
	138	$H + NO_2 \Rightarrow OH + NO$	1.47×10^{-10}	[3]
	139	$H + NO_2^- \Rightarrow OH^- + NO$	4×10^{-10}	[3]
	140	$H + HNO_2 \Rightarrow NO_2 + H_2$	$2 \times 10^{-11}\exp(-3700/T_g)$	[3]
	141	$H + O_3 \Rightarrow OH + O_2$	$2.8 \times 10^{-11}(T_g/300)^{0.75}$	[3]
	142	$H + O_3^- \Rightarrow OH^- + O_2$	8.4×10^{-10}	[3]
	143	$H + NO_3 \Rightarrow OH + NO_2$	$5.8 \times 10^{-10}\exp(-750/T_g)$	[3]
	144	$H + HNO_3 \Rightarrow NO_2 + H_2O$	$1.39 \times 10^{-14}(T_g/298)^{3.29}\exp(-3160/T_g)$	[3]
H ⁻	145	$H^- + H_2^+ \Rightarrow H + H_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	146	$H^- + H_2^+ \Rightarrow 3H$	10^{-7}	[3]
	147	$H^- + N^+ \Rightarrow N + H$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	148	$H^- + O^+ \Rightarrow O + H$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]

	149	$\text{H}^- + \text{OH}^+ \Rightarrow \text{H} + \text{OH}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	150	$\text{H}^- + \text{OH}^+ \Rightarrow 2\text{H} + \text{O}$	10^{-7}	[3]
	151	$\text{H}^- + \text{NO}^+ \Rightarrow \text{H} + \text{NO}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	152	$\text{H}^- + \text{NO}^+ \Rightarrow \text{H} + \text{N} + \text{O}$	10^{-7}	[3]
	153	$\text{H}^- + \text{H}_2\text{O} \Rightarrow \text{OH}^- + \text{H}_2$	3.8×10^{-9}	[3]
	154	$\text{H}^- + \text{H}_2\text{O}^+ \Rightarrow \text{H} + \text{H}_2\text{O}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	155	$\text{H}^- + \text{H}_2\text{O}^+ \Rightarrow 2\text{H} + \text{OH}$	10^{-7}	[3]
	156	$\text{H}^- + \text{N}_2^+ \Rightarrow \text{H} + \text{N}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	157	$\text{H}^- + \text{N}_2^+ \Rightarrow \text{H} + 2\text{N}$	10^{-7}	[3]
	158	$\text{H}^- + \text{O}_2^+ \Rightarrow \text{H} + \text{O}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	159	$\text{H}^- + \text{O}_2^+ \Rightarrow \text{H} + 2\text{O}$	10^{-7}	[3]
	160	$\text{H}^- + \text{N}_2\text{O}^+ \Rightarrow \text{H} + \text{N}_2\text{O}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	161	$\text{H}^- + \text{N}_2\text{O}^+ \Rightarrow \text{H} + \text{N}_2 + \text{O}$	10^{-7}	[3]
	162	$\text{H}^- + \text{N}_2\text{O} \Rightarrow \text{OH}^- + \text{N}_2$	1.1×10^{-9}	[3]
	163	$\text{H}^- + \text{NO}_2^+ \Rightarrow \text{H} + \text{NO}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
H_2^+	164	$\text{H}^- + \text{NO}_2^+ \Rightarrow \text{H} + \text{N} + \text{O}_2$	10^{-7}	[3]
	165	$\text{H}^- + \text{NO}_2 \Rightarrow \text{NO}_2^- + \text{H}$	2.9×10^{-9}	[3]
	166	$\text{H}_2^+ + \text{O}^- \Rightarrow \text{O} + \text{H}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	167	$\text{H}_2^+ + \text{O}^- \Rightarrow \text{O} + 2\text{H}$	10^{-7}	[3]
	168	$\text{H}_2^+ + \text{OH}^- \Rightarrow \text{OH} + \text{H}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	169	$\text{H}_2^+ + \text{OH}^- \Rightarrow \text{OH} + 2\text{H}$	10^{-7}	[3]
	170	$\text{H}_2^+ + \text{H}_2\text{O} \Rightarrow \text{H}_2\text{O}^+ + \text{H}_2$	3.86×10^{-9}	[3]
	171	$\text{H}_2^+ + \text{NO}^- \Rightarrow \text{NO} + \text{H}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	172	$\text{H}_2^+ + \text{NO}^- \Rightarrow \text{NO} + 2\text{H}$	10^{-7}	[3]
	173	$\text{H}_2^+ + \text{O}_2 \Rightarrow \text{O}_2^+ + \text{H}_2$	7.83×10^{-10}	[3]
	174	$\text{H}_2^+ + \text{O}_2^- \Rightarrow \text{O}_2 + \text{H}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	175	$\text{H}_2^+ + \text{O}_2^- \Rightarrow \text{O}_2 + 2\text{H}$	10^{-7}	[3]
	176	$\text{H}_2^+ + \text{N}_2\text{O}^- \Rightarrow \text{N}_2\text{O} + \text{H}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	177	$\text{H}_2^+ + \text{N}_2\text{O}^- \Rightarrow \text{N}_2\text{O} + 2\text{H}$	10^{-7}	[3]
	178	$\text{H}_2^+ + \text{NO}_2^- \Rightarrow \text{NO}_2 + \text{H}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
H_2	179	$\text{H}_2^+ + \text{NO}_2^- \Rightarrow \text{NO}_2 + 2\text{H}$	10^{-7}	[3]
	180	$\text{H}_2^+ + \text{O}_3^- \Rightarrow \text{O}_3 + \text{H}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	181	$\text{H}_2^+ + \text{O}_3^- \Rightarrow \text{O}_3 + 2\text{H}$	10^{-7}	[3]
	182	$\text{H}_2^+ + \text{NO}_3^- \Rightarrow \text{NO}_3 + \text{H}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	183	$\text{H}_2^+ + \text{NO}_3^- \Rightarrow \text{NO}_3 + 2\text{H}$	10^{-7}	[3]
He	184	$\text{H}_2 + \text{O}^+ \Rightarrow \text{OH}^+ + \text{H}$	1.7×10^{-9}	[3]
	185	$\text{H}_2 + \text{O}^- \Rightarrow \text{OH}^- + \text{H}$	3.3×10^{-11}	[3]
	186	$\text{H}_2 + \text{O}^- \Rightarrow \text{H}_2\text{O} + \text{e}$	7×10^{-10}	[3]
	187	$\text{H}_2 + \text{OH}^+ \Rightarrow \text{H}_2\text{O}^+ + \text{H}$	9.7×10^{-10}	[3]
	188	$\text{H}_2 + \text{OH} \Rightarrow \text{H} + \text{H}_2\text{O}$	$3.2 \times 10^{-11} \exp(-2600/T_g)$	[3]
He	189	$\text{He} + \text{He}(3^1\text{S}) \Rightarrow \text{He}_2^+ + \text{e}$	3.6×10^{-12}	[1]
	190	$\text{He} + \text{He}(3^1\text{P}) \Rightarrow \text{He}_2^+ + \text{e}$	1.11×10^{-10}	[1]
	191	$\text{He} + \text{He}(3^1\text{D}) \Rightarrow \text{He}_2^+ + \text{e}$	7.36×10^{-10}	[1]
	192	$\text{He} + \text{He}(3^3\text{S}) \Rightarrow \text{He}_2^+ + \text{e}$	3.625×10^{-13}	[1]
	193	$\text{He} + \text{He}(3^3\text{P}) \Rightarrow \text{He}_2^+ + \text{e}$	5.7263×10^{-11}	[1]
	194	$\text{He} + \text{He}(3^3\text{D}) \Rightarrow \text{He}_2^+ + \text{e}$	1.62×10^{-10}	[1]
	195	$\text{He} + \text{He}(4^3\text{S}) \Rightarrow \text{He}_2^+ + \text{e}$	7.6×10^{-10}	[1]
	196	$\text{He} + \text{He}(4^3\text{P}) \Rightarrow \text{He}_2^+ + \text{e}$	6.8×10^{-10}	[1]
	197	$\text{He} + \text{He}(4^3\text{D}) \Rightarrow \text{He}_2^+ + \text{e}$	8.7×10^{-10}	[1]
	198	$\text{He} + \text{He}(4^3\text{D}) \Rightarrow \text{He}_2^+ + \text{e}$	9.75×10^{-10}	[1]

199	$\text{He} + \text{He}(4^1\text{D}) \Rightarrow \text{He}_2^+ + \text{e}$	1.626×10^{-9}	[1]
200	$\text{He} + \text{He}(4^3\text{F}) \Rightarrow \text{He}_2^+ + \text{e}$	9.1973×10^{-10}	[1]
201	$\text{He} + \text{He}(4^1\text{F}) \Rightarrow \text{He}_2^+ + \text{e}$	9.26×10^{-10}	[1]
202	$\text{He} + \text{He}(4^1\text{P}) \Rightarrow \text{He}_2^+ + \text{e}$	4.7×10^{-10}	[1]
203	$\text{He} + \text{He}(3^3\text{D}) \Rightarrow \text{He}(3^3\text{P}) + \text{He}$	6.7×10^{-11}	[1]
204	$\text{He} + \text{He}(3^1\text{P}) \Rightarrow \text{He}(3^1\text{D}) + \text{He}$	5.8×10^{-10}	[1]
205	$\text{He} + \text{He}(4^3\text{P}) \Rightarrow \text{He}(4^3\text{S}) + \text{He}$	10^{-10}	[1]
206	$\text{He} + \text{He}(4^3\text{D}) \Rightarrow \text{He}(4^3\text{P}) + \text{He}$	9.3×10^{-11}	[1]
207	$\text{He} + \text{He}(4^3\text{D}) \Rightarrow \text{He}(4^3\text{S}) + \text{He}$	5.8×10^{-11}	[1]
208	$\text{He} + \text{He}(4^1\text{D}) \Rightarrow \text{He}(4^1\text{S}) + \text{He}$	2.2×10^{-10}	[1]
209	$\text{He} + \text{He}(4^3\text{F}) \Rightarrow \text{He}(4^3\text{D}) + \text{He}$	1.8×10^{-10}	[1]
210	$\text{He} + \text{He}(4^3\text{F}) \Rightarrow \text{He}(4^3\text{P}) + \text{He}$	6.6×10^{-11}	[1]
211	$\text{He} + \text{He}(4^3\text{F}) \Rightarrow \text{He}(4^3\text{S}) + \text{He}$	4.1×10^{-11}	[1]
212	$\text{He} + \text{He}(4^1\text{F}) \Rightarrow \text{He}(4^1\text{D}) + \text{He}$	5.9×10^{-10}	[1]
213	$\text{He} + \text{He}(4^1\text{F}) \Rightarrow \text{He}(4^1\text{S}) + \text{He}$	1.6×10^{-10}	[1]
214	$\text{He} + \text{He}(4^1\text{P}) \Rightarrow \text{He}(4^1\text{F}) + \text{He}$	7.6×10^{-10}	[1]
215	$\text{He} + \text{He}(4^1\text{P}) \Rightarrow \text{He}(4^1\text{D}) + \text{He}$	7.4×10^{-10}	[1]
216	$\text{He} + \text{He}(4^1\text{P}) \Rightarrow \text{He}(4^1\text{S}) + \text{He}$	3.6×10^{-10}	[1]
217	$\text{He} + \text{He}(3^3\text{P}) \Rightarrow \text{He}(3^3\text{D}) + \text{He}$	8.1×10^{-11}	[1]
218	$\text{He} + \text{He}(3^1\text{D}) \Rightarrow \text{He}(3^1\text{P}) + \text{He}$	3.3×10^{-10}	[1]
219	$\text{He} + \text{He}(4^3\text{S}) \Rightarrow \text{He}(4^3\text{P}) + \text{He}$	1.7×10^{-10}	[1]
220	$\text{He} + \text{He}(4^3\text{P}) \Rightarrow \text{He}(4^3\text{D}) + \text{He}$	1.4×10^{-10}	[1]
221	$\text{He} + \text{He}(4^3\text{S}) \Rightarrow \text{He}(4^3\text{D}) + \text{He}$	1.5×10^{-10}	[1]
222	$\text{He} + \text{He}(4^1\text{S}) \Rightarrow \text{He}(4^1\text{D}) + \text{He}$	8.2×10^{-10}	[1]
223	$\text{He} + \text{He}(4^3\text{D}) \Rightarrow \text{He}(4^3\text{F}) + \text{He}$	2.5×10^{-10}	[1]
224	$\text{He} + \text{He}(4^3\text{P}) \Rightarrow \text{He}(4^3\text{F}) + \text{He}$	1.3×10^{-10}	[1]
225	$\text{He} + \text{He}(4^3\text{S}) \Rightarrow \text{He}(4^3\text{F}) + \text{He}$	1.5×10^{-10}	[1]
226	$\text{He} + \text{He}(4^1\text{D}) \Rightarrow \text{He}(4^1\text{F}) + \text{He}$	8.3×10^{-10}	[1]
227	$\text{He} + \text{He}(4^1\text{S}) \Rightarrow \text{He}(4^1\text{F}) + \text{He}$	8.3×10^{-11}	[1]
228	$\text{He} + \text{He}(4^1\text{F}) \Rightarrow \text{He}(4^1\text{P}) + \text{He}$	3.2×10^{-10}	[1]
229	$\text{He} + \text{He}(4^1\text{D}) \Rightarrow \text{He}(4^1\text{P}) + \text{He}$	4.3×10^{-10}	[1]
230	$\text{He} + \text{He}(4^1\text{S}) \Rightarrow \text{He}(4^1\text{P}) + \text{He}$	7.8×10^{-10}	[1]
231	$2\text{He} + \text{He}(2^1\text{P}) \Rightarrow 3\text{He}$	1.8×10^{-31}	[1]
232	$2\text{He} + \text{He}(2^1\text{S}) \Rightarrow 3\text{He}$	1.3×10^{-33}	[1]
233	$2\text{He} + \text{He}^* \Rightarrow \text{He}_2^+ + \text{He}$	$1.4 \times 10^{-31}(\text{T}_\text{e}/300)^{-0.6}$	[1]
234	$\text{He} + \text{He}_2^* \Rightarrow 2\text{He} + \text{He}^*$	$1.4 \times 10^{-6}\text{T}_\text{e}^{-0.67}\exp(-28100/\text{T}_\text{e})$	[1]
235	$\text{He}(2^3\text{P}) \Rightarrow \text{He}(2^3\text{S}) + \text{h}\nu(1083\text{nm})$	1.022×10^7	[1]
236	$\text{He}(2^1\text{P}) \Rightarrow \text{He}(2^1\text{S}) + \text{h}\nu(2058.7\text{nm})$	1.976×10^6	[1]
237	$\text{He}(2^1\text{P}) \Rightarrow \text{He} + \text{h}\nu(58.43\text{nm})$	1.799×10^9	[1]
238	$\text{He}(3^1\text{S}) \Rightarrow \text{He}(2^1\text{P}) + \text{h}\nu(728.14\text{nm})$	1.81×10^7	[1]
239	$\text{He}(3^1\text{P}) \Rightarrow \text{He}(2^1\text{S}) + \text{h}\nu(501.57\text{nm})$	1.338×10^7	[1]
240	$\text{He}(3^1\text{P}) \Rightarrow \text{He} + \text{h}\nu(53.7\text{nm})$	5.66×10^8	[1]
241	$\text{He}(3^1\text{D}) \Rightarrow \text{He}(2^1\text{P}) + \text{h}\nu(667.82\text{nm})$	6.38×10^7	[1]
242	$\text{He}(3^3\text{S}) \Rightarrow \text{He}(2^3\text{P}) + \text{h}\nu(706.52\text{nm})$	1.54×10^7	[1]
243	$\text{He}(3^3\text{P}) \Rightarrow \text{He}(2^3\text{S}) + \text{h}\nu(388.86\text{nm})$	9.478×10^6	[1]
244	$\text{He}(3^3\text{D}) \Rightarrow \text{He}(2^3\text{P}) + \text{h}\nu(587.56\text{nm})$	7.06×10^7	[1]
245	$\text{He}(4^1\text{S}) \Rightarrow \text{He}(2^1\text{P}) + \text{h}\nu(504.77\text{nm})$	6.55×10^6	[1]
246	$\text{He}(4^1\text{S}) \Rightarrow \text{He}(3^1\text{P}) + \text{h}\nu(211.37\text{nm})$	4.59×10^6	[1]
247	$\text{He}(4^1\text{P}) \Rightarrow \text{He}(2^1\text{S}) + \text{h}\nu(396.47\text{nm})$	7.17×10^6	[1]

	248	$\text{He}(4^1\text{P}) \Rightarrow \text{He} + \text{h}\nu(52.22\text{nm})$	2.46×10^8	[1]
	249	$\text{He}(4^1\text{D}) \Rightarrow \text{He}(2^1\text{P}) + \text{h}\nu(492.19\text{nm})$	2.02×10^7	[1]
	250	$\text{He}(4^1\text{D}) \Rightarrow \text{He}(3^1\text{P}) + \text{h}\nu(190.89\text{nm})$	7.11×10^6	[1]
	251	$\text{He}(4^1\text{F}) \Rightarrow \text{He}(3^1\text{D}) + \text{h}\nu(186.97\text{nm})$	1.38×10^7	[1]
	252	$\text{He}(4^3\text{S}) \Rightarrow \text{He}(2^3\text{P}) + \text{h}\nu(471.32\text{nm})$	5.89×10^6	[1]
	253	$\text{He}(4^3\text{S}) \Rightarrow \text{He}(3^3\text{P}) + \text{h}\nu(211.25\text{nm})$	3.62×10^6	[1]
	254	$\text{He}(4^3\text{P}) \Rightarrow \text{He}(2^3\text{S}) + \text{h}\nu(318.77\text{nm})$	5.05×10^6	[1]
	255	$\text{He}(4^3\text{D}) \Rightarrow \text{He}(2^3\text{P}) + \text{h}\nu(447.15\text{nm})$	2.51×10^7	[1]
	256	$\text{He}(4^3\text{D}) \Rightarrow \text{He}(3^3\text{P}) + \text{h}\nu(170.02\text{nm})$	6.68×10^6	[1]
	257	$\text{He}(4^3\text{F}) \Rightarrow \text{He}(3^3\text{D}) + \text{h}\nu(186.85\text{nm})$	1.55×10^6	[1]
N^+	258	$\text{N}^+ + \text{O} \Rightarrow \text{O}^+ + \text{N}$	10^{-12}	[3]
	259	$\text{N}^+ + \text{O} + \text{M} \Rightarrow \text{NO}^+ + \text{M}$	10^{-29}	[3]
	260	$\text{N}^+ + \text{O}^- \Rightarrow \text{O} + \text{N}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	261	$\text{N}^+ + \text{OH} \Rightarrow \text{OH}^+ + \text{N}$	3.4×10^{-10}	[3]
	262	$\text{N}^+ + \text{OH} \Rightarrow \text{NO}^+ + \text{H}$	3.4×10^{-10}	[3]
	263	$\text{N}^+ + \text{N} + \text{M} \Rightarrow \text{N}_2^+ + \text{M}$	10^{-29}	[3]
	264	$\text{N}^+ + \text{H}_2\text{O} \Rightarrow \text{H}_2\text{O}^+ + \text{N}$	1.19×10^{-9}	[3]
	265	$\text{N}^+ + \text{H}_2\text{O} \Rightarrow \text{NO}^+ + \text{H}_2$	2.1×10^{-10}	[3]
	266	$\text{N}^+ + \text{NO} \Rightarrow \text{NO}^+ + \text{N}$	4.72×10^{-10}	[3]
	267	$\text{N}^+ + \text{NO} \Rightarrow \text{N}_2^+ + \text{O}$	8.33×10^{-11}	[3]
	268	$\text{N}^+ + \text{NO} \Rightarrow \text{O}^+ + \text{N}_2$	10^{-12}	[3]
	269	$\text{N}^+ + \text{NO}^- \Rightarrow \text{NO} + \text{N}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	270	$\text{N}^+ + \text{O}_2 \Rightarrow \text{NO}^+ + \text{O}$	2.7×10^{-10}	[3]
	271	$\text{N}^+ + \text{O}_2 \Rightarrow \text{O}^+ + \text{NO}$	2.8×10^{-11}	[3]
	272	$\text{N}^+ + \text{O}_2 \Rightarrow \text{O}_2^+ + \text{N}$	3×10^{-10}	[3]
	273	$\text{N}^+ + \text{O}_2^- \Rightarrow \text{O}_2 + \text{N}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	274	$\text{N}^+ + \text{O}_3^- \Rightarrow \text{O}_3 + \text{N}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	275	$\text{N}^+ + \text{N}_2\text{O} \Rightarrow \text{NO}^+ + \text{N}_2$	5.5×10^{-10}	[3]
	276	$\text{N}^+ + \text{N}_2\text{O}^- \Rightarrow \text{N}_2\text{O} + \text{N}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	277	$\text{N}^+ + \text{NO}_2 \Rightarrow \text{NO}_2^+ + \text{N}$	3×10^{-10}	[3]
	278	$\text{N}^+ + \text{NO}_2 \Rightarrow \text{NO}^+ + \text{NO}$	5×10^{-10}	[3]
	279	$\text{N}^+ + \text{NO}_2^- \Rightarrow \text{NO}_2 + \text{N}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	280	$\text{N}^+ + \text{O}_3 \Rightarrow \text{NO}^+ + \text{O}_2$	5×10^{-10}	[3]
	281	$\text{N}^+ + \text{NO}_3^- \Rightarrow \text{NO}_3 + \text{N}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
N	282	$\text{N} + \text{O}^+ + \text{M} \Rightarrow \text{NO}^+ + \text{M}$	10^{-29}	[3]
	283	$\text{N} + \text{O} + \text{M} \Rightarrow \text{NO} + \text{M}$	$6.3 \times 10^{-33}\text{exp}(140/T_g)$	[3]
	284	$\text{N} + \text{O}^- \Rightarrow \text{NO} + \text{e}$	2.6×10^{-10}	[4]
	285	$\text{N} + \text{OH} \Rightarrow \text{H} + \text{NO}$	7.5×10^{-11}	[3]
	286	$\text{N} + \text{H}_2\text{O}^+ \Rightarrow \text{NO}^+ + \text{H}_2$	1.9×10^{-10}	[3]
	287	$2\text{N} + \text{M} \Rightarrow \text{N}_2 + \text{M}$	$8.3 \times 10^{-34}\text{exp}(500/T_g)$	[3]
	288	$\text{N} + \text{N}_2^+ \Rightarrow \text{N}^+ + \text{N}_2$	10^{-12}	[3]
	289	$\text{N} + \text{NO}^+ + \text{M} \Rightarrow \text{N}_2\text{O}^+ + \text{M}$	$10^{-29}(300/T_g)$	[3]
	290	$\text{N} + \text{NO} \Rightarrow \text{N}_2 + \text{O}$	$2.1 \times 10^{-11}\text{exp}(100/T_g)$	[3]
	291	$\text{N} + \text{O}_2^+ \Rightarrow \text{NO}^+ + \text{O}$	1.5×10^{-10}	[3]
	292	$\text{N} + \text{O}_2 \Rightarrow \text{NO} + \text{O}$	$1.5 \times 10^{-11}\text{exp}(-3600/T_g)$	[3]
	293	$\text{N} + \text{O}_2^- \Rightarrow \text{NO}_2 + \text{e}$	5×10^{-10}	[4]
	294	$\text{N} + \text{HO}_2 \Rightarrow \text{NO} + \text{OH}$	$1.7 \times 10^{-11}\text{exp}(-1000/T_g)$	[3]
	295	$\text{N} + \text{NO}_2 \Rightarrow \text{N}_2\text{O} + \text{O}$	$5.8 \times 10^{-12}\text{exp}(220/T_g)$	[3]
	296	$\text{N} + \text{NO}_2 \Rightarrow \text{N}_2 + 2\text{O}$	9.1×10^{-13}	[3]
	297	$\text{N} + \text{NO}_2 \Rightarrow 2\text{NO}$	6×10^{-13}	[3]

	298	$N + NO_2 \Rightarrow N_2 + O_2$	7×10^{-13}	[3]
	299	$N + NO_2^- \Rightarrow N_2 + O_2 + e$	10^{-12}	[3]
	300	$N + O_3 \Rightarrow NO + O_2$	5×10^{-16}	[3]
	301	$N + NO_3^- \Rightarrow N_2 + O_3 + e$	10^{-12}	[3]
O^+	302	$O^+ + O + M \Rightarrow O_2^+ + M$	10^{-29}	[3]
	303	$O^+ + O^- \Rightarrow 2O$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[4]
	304	$O^+ + OH \Rightarrow O_2^+ + H$	3.6×10^{-10}	[3]
	305	$O^+ + OH \Rightarrow OH^+ + O$	3.3×10^{-10}	[3]
	306	$O^+ + OH^- \Rightarrow O + OH$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	307	$O^+ + NO \Rightarrow NO^+ + O$	10^{-12}	[3]
	308	$O^+ + NO \Rightarrow O_2^+ + N$	3×10^{-12}	[3]
	309	$O^+ + H_2O \Rightarrow H_2O^+ + O$	3.2×10^{-9}	[3]
	310	$O^+ + N_2 + M \Rightarrow NO^+ + N + M$	$6 \times 10^{-29}(300/T_g)^2$	[3]
	311	$O^+ + NO^- \Rightarrow NO + O$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	312	$O^+ + O_2 \Rightarrow O_2^+ + O$	$2.1 \times 10^{-11}(300/T_g)^{0.5}$	[3]
	313	$O^+ + O_2^- \Rightarrow O_2 + O$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	314	$O^+ + N_2O \Rightarrow N_2O^+ + O$	6.3×10^{-10}	[3]
	315	$O^+ + N_2O \Rightarrow NO^+ + NO$	2.3×10^{-10}	[3]
	316	$O^+ + N_2O \Rightarrow O_2^+ + N_2$	2×10^{-11}	[3]
	317	$O^+ + N_2O^- \Rightarrow N_2O + O$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	318	$O^+ + NO_2 \Rightarrow NO^+ + O_2$	5×10^{-10}	[3]
	319	$O^+ + NO_2 \Rightarrow NO_2^+ + O$	1.6×10^{-9}	[3]
	320	$O^+ + NO_2^- \Rightarrow NO_2 + O$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	321	$O^+ + O_3 \Rightarrow O_2^+ + O_2$	10^{-10}	[3]
	322	$O^+ + O_3^- \Rightarrow O_3 + O$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	323	$O^+ + NO_3^- \Rightarrow NO_3 + O$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
O	324	$O + O^- \Rightarrow O_2 + e$	1.4×10^{-10}	[3]
	325	$O + OH \Rightarrow H + O_2$	$2.2 \times 10^{-11} \exp(-350/T_g)$	[3]
	326	$O + OH^- \Rightarrow HO_2 + e$	2×10^{-10}	[3]
	327	$O + H_2O^+ \Rightarrow O_2^+ + H_2$	5.5×10^{-11}	[3]
	328	$O + N_2^+ \Rightarrow O^+ + N_2$	$1 \times 10^{-11}(300/T_g)^{0.5}$	[3]
	329	$O + N_2^+ \Rightarrow NO^+ + N$	1.4×10^{-10}	[3]
	330	$O + NO + M \Rightarrow NO_2 + M$	$10^{-31}(300/T_g)^{1.6}$	[3]
	331	$O + NO^- \Rightarrow O^- + NO$	3×10^{-10}	[3]
	332	$O + HNO \Rightarrow OH + NO$	5.99×10^{-11}	[3]
	333	$O + O_2 + M \Rightarrow O_3 + M$	$3.4 \times 10^{-34}(T_g/300)^{-1.2}$	[8]
	334	$O + O_2^- \Rightarrow O^- + O_2$	3.3×10^{-10}	[3]
	335	$O + O_2^- \Rightarrow O_3 + e$	1.5×10^{-10}	[3]
	336	$2O + M \Rightarrow O_2 + M$	$3.2 \times 10^{-35} \exp(900/T_g)$	[3]
	337	$O + HO_2 \Rightarrow OH + O_2$	$8.3 \times 10^{-11} \exp(-500/T_g)$	[3]
	338	$O + H_2O_2 \Rightarrow OH + HO_2$	$3.3 \times 10^{-11} \exp(-2950/T_g)$	[3]
	339	$O + NO_2 \Rightarrow NO + O_2$	$6.5 \times 10^{-12} \exp(120/T_g)$	[3]
	340	$O + NO_2 + M \Rightarrow NO_3 + M$	$9 \times 10^{-32}(300/T_g)^2$	[3]
	341	$O + NO_2^- \Rightarrow NO_3 + e$	10^{-12}	[3]
	342	$O + HNO_2 \Rightarrow NO_2 + OH$	$2 \times 10^{-11} \exp(-3000/T_g)$	[3]
	343	$O + O_3 \Rightarrow 2O_2$	$8 \times 10^{-12} \exp(-2060/T_g)$	[3]
	344	$O + O_3^- \Rightarrow 2O_2 + e$	3×10^{-10}	[3]
	345	$O + O_3^- \Rightarrow O_2^- + O_2$	10^{-11}	[3]
	346	$O + NO_3 \Rightarrow O_2 + NO_2$	1.7×10^{-11}	[3]
	347	$O + NO_3^- \Rightarrow NO_2 + O_2 + e$	10^{-12}	[3]

O ⁻	348	$O^- + OH^+ \Rightarrow 2O + H$	10^{-7}	[3]
	349	$O^- + OH^+ \Rightarrow O + OH$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	350	$O^- + N_2 \Rightarrow N_2O + e$	10^{-12}	[3]
	351	$O^- + NO \Rightarrow NO_2 + e$	2.6×10^{-10}	[3]
	352	$O^- + NO + M \Rightarrow NO_2^- + M$	10^{-29}	[3]
	353	$O^- + N_2^+ \Rightarrow O + N_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	354	$O^- + N_2^+ \Rightarrow O + 2N$	10^{-7}	[3]
	355	$O^- + NO^+ \Rightarrow 2O + N$	10^{-7}	[3]
	356	$O^- + NO^+ \Rightarrow O + NO$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	357	$O^- + O_2^+ \Rightarrow 3O$	10^{-7}	[3]
	358	$O^- + O_2^+ \Rightarrow O + O_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	359	$O^- + O_2 \Rightarrow O_3 + e$	10^{-12}	[3]
	360	$O^- + O_2 + M \Rightarrow O_3^- + M$	$1.1 \times 10^{-30}(300/T_g)$	[3]
	361	$O^- + H_2O^+ \Rightarrow O + OH + H$	10^{-7}	[3]
	362	$O^- + H_2O^+ \Rightarrow O + H_2O$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	363	$O^- + H_2O \Rightarrow OH^- + OH$	1.4×10^{-9}	[3]
	364	$O^- + N_2O^+ \Rightarrow O + N_2O$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	365	$O^- + N_2O^+ \Rightarrow 2O + N_2$	10^{-7}	[3]
	366	$O^- + N_2O \Rightarrow NO^- + NO$	2×10^{-10}	[3]
	367	$O^- + N_2O \Rightarrow N_2O^- + O$	2×10^{-12}	[3]
	368	$O^- + NO_2^+ \Rightarrow O + NO_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	369	$O^- + NO_2^+ \Rightarrow O + N + O_2$	10^{-7}	[3]
	370	$O^- + NO_2 \Rightarrow NO_2^- + O$	1.2×10^{-9}	[3]
	371	$O^- + O_3 \Rightarrow O_3^- + O$	8×10^{-10}	[3]
	372	$O^- + O_3 \Rightarrow 2O_2 + e$	3×10^{-10}	[3]
	373	$O^- + NO_3 \Rightarrow NO_3^- + O$	3×10^{-10}	[3]
OH ⁺	374	$OH^+ + OH \Rightarrow H_2O^+ + O$	7×10^{-10}	[3]
	375	$OH^+ + OH^- \Rightarrow 2OH$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	376	$OH^+ + OH^- \Rightarrow OH + O + H$	10^{-7}	[3]
	377	$OH^+ + H_2O \Rightarrow H_2O^+ + OH$	1.59×10^{-9}	[3]
	378	$OH^+ + NO \Rightarrow NO^+ + OH$	5.2×10^{-10}	[3]
	379	$OH^+ + NO^- \Rightarrow NO + OH$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	380	$OH^+ + NO^- \Rightarrow NO + O + H$	10^{-7}	[3]
	381	$OH^+ + O_2 \Rightarrow O_2^+ + OH$	5.9×10^{-10}	[3]
	382	$OH^+ + O_2^- \Rightarrow O_2 + OH$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	383	$OH^+ + O_2^- \Rightarrow O_2 + O + H$	10^{-7}	[3]
	384	$OH^+ + N_2O \Rightarrow N_2O^+ + OH$	2.13×10^{-10}	[3]
	385	$OH^+ + N_2O^- \Rightarrow N_2O + OH$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	386	$OH^+ + N_2O^- \Rightarrow N_2O + O + H$	10^{-7}	[3]
	387	$OH^+ + NO_2 \Rightarrow NO^+ + HO_2$	1.3×10^{-9}	[3]
	388	$OH^+ + NO_2^- \Rightarrow NO_2 + OH$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	389	$OH^+ + NO_2^- \Rightarrow NO_2 + O + H$	10^{-7}	[3]
	390	$OH^+ + O_3^- \Rightarrow O_3 + OH$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	391	$OH^+ + O_3^- \Rightarrow O_3 + O + H$	10^{-7}	[3]
	392	$OH^+ + NO_3^- \Rightarrow NO_3 + OH$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	393	$OH^+ + NO_3^- \Rightarrow NO_3 + O + H$	10^{-7}	[3]
OH	394	$OH(A^2\Sigma^+v_0) \Rightarrow OH + hv(308.9nm)$	3.48×10^4	[9]
	395	$2OH \Rightarrow O + H_2O$	$8.8 \times 10^{-12} \exp(-503/T_g)$	[3]
	396	$2OH + M \Rightarrow H_2O_2 + M$	$6.9 \times 10^{-31}(T_g/300)^{-0.8}$	[3]
	397	$OH + NO + M \Rightarrow HNO_2 + M$	$7.4 \times 10^{-31}(300/T_g)^{2.4}$	[3]

	398	$\text{OH} + \text{HNO} \Rightarrow \text{NO} + \text{H}_2\text{O}$	$8 \times 10^{-11} \exp(-500/T_g)$	[3]
	399	$\text{OH} + \text{HO}_2 \Rightarrow \text{O}_2 + \text{H}_2\text{O}$	$4.8 \times 10^{-11} \exp(250/T_g)$	[3]
	400	$\text{OH} + \text{H}_2\text{O}_2 \Rightarrow \text{HO}_2 + \text{H}_2\text{O}$	$2.9 \times 10^{-12} \exp(-160/T_g)$	[3]
	401	$\text{OH} + \text{NO}_2 + \text{M} \Rightarrow \text{HNO}_3 + \text{M}$	$2.2 \times 10^{-30} (300/T_g)^{2.9}$	[3]
	402	$\text{OH} + \text{HNO}_2 \Rightarrow \text{NO}_2 + \text{H}_2\text{O}$	$1.8 \times 10^{-11} \exp(-390/T_g)$	[3]
	403	$\text{OH} + \text{O}_3 \Rightarrow \text{HO}_2 + \text{O}_2$	$1.6 \times 10^{-12} \exp(-1000/T_g)$	[3]
	404	$\text{OH} + \text{NO}_3 \Rightarrow \text{HO}_2 + \text{NO}_2$	2×10^{-11}	[3]
	405	$\text{OH} + \text{HNO}_3 \Rightarrow \text{NO}_3 + \text{H}_2\text{O}$	$1.5 \times 10^{-14} \exp(650/T_g)$	[3]
OH^-	406	$\text{OH}^- + \text{N}^+ \Rightarrow \text{N} + \text{OH}$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	407	$\text{OH}^- + \text{H}_2\text{O}^+ \Rightarrow \text{OH} + \text{H}_2\text{O}$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	408	$\text{OH}^- + \text{H}_2\text{O}^+ \Rightarrow 2\text{OH} + \text{H}$	10^{-7}	[3]
	409	$\text{OH}^- + \text{N}_2^+ \Rightarrow \text{OH} + \text{N}_2$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	410	$\text{OH}^- + \text{N}_2^+ \Rightarrow \text{OH} + 2\text{N}$	10^{-7}	[3]
	411	$\text{OH}^- + \text{NO}^+ \Rightarrow \text{OH} + \text{NO}$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	412	$\text{OH}^- + \text{NO}^+ \Rightarrow \text{OH} + \text{N} + \text{O}$	10^{-7}	[3]
	413	$\text{OH}^- + \text{O}_2^+ \Rightarrow \text{OH} + \text{O}_2$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	414	$\text{OH}^- + \text{O}_2^+ \Rightarrow \text{OH} + 2\text{O}$	10^{-7}	[3]
	415	$\text{OH}^- + \text{N}_2\text{O}^+ \Rightarrow \text{OH} + \text{N}_2\text{O}$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	416	$\text{OH}^- + \text{N}_2\text{O}^+ \Rightarrow \text{OH} + \text{N}_2 + \text{O}$	10^{-7}	[3]
	417	$\text{OH}^- + \text{NO}_2^+ \Rightarrow \text{OH} + \text{NO}_2$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	418	$\text{OH}^- + \text{NO}_2^+ \Rightarrow \text{OH} + \text{N} + \text{O}_2$	10^{-7}	[3]
	419	$\text{OH}^- + \text{NO}_2 \Rightarrow \text{NO}_2^- + \text{OH}$	1.9×10^{-9}	[3]
	420	$\text{OH}^- + \text{O}_3 \Rightarrow \text{O}_3^- + \text{OH}$	9×10^{-10}	[3]
H_2O^+	421	$\text{H}_2\text{O}^+ + \text{O}_2 \Rightarrow \text{O}_2^+ + \text{H}_2\text{O}$	4.3×10^{-10}	[3]
	422	$\text{H}_2\text{O}^+ + \text{O}_2^- \Rightarrow \text{O}_2 + \text{H}_2\text{O}$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	423	$\text{H}_2\text{O}^+ + \text{O}_2^- \Rightarrow \text{O}_2 + \text{OH} + \text{H}$	10^{-7}	[3]
	424	$\text{H}_2\text{O}^+ + \text{NO} \Rightarrow \text{NO}^+ + \text{H}_2\text{O}$	4.6×10^{-10}	[3]
	425	$\text{H}_2\text{O}^+ + \text{NO}^- \Rightarrow \text{NO} + \text{H}_2\text{O}$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	426	$\text{H}_2\text{O}^+ + \text{NO}^- \Rightarrow \text{NO} + \text{OH} + \text{H}$	10^{-7}	[3]
	427	$\text{H}_2\text{O}^+ + \text{N}_2\text{O}^- \Rightarrow \text{N}_2\text{O} + \text{H}_2\text{O}$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	428	$\text{H}_2\text{O}^+ + \text{N}_2\text{O}^- \Rightarrow \text{N}_2\text{O} + \text{OH} + \text{H}$	10^{-7}	[3]
	429	$\text{H}_2\text{O}^+ + \text{NO}_2 \Rightarrow \text{NO}_2^+ + \text{H}_2\text{O}$	1.2×10^{-9}	[3]
	430	$\text{H}_2\text{O}^+ + \text{NO}_2^- \Rightarrow \text{NO}_2 + \text{H}_2\text{O}$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	431	$\text{H}_2\text{O}^+ + \text{NO}_2^- \Rightarrow \text{NO}_2 + \text{OH} + \text{H}$	10^{-7}	[3]
	432	$\text{H}_2\text{O}^+ + \text{O}_3^- \Rightarrow \text{O}_3 + \text{H}_2\text{O}$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	433	$\text{H}_2\text{O}^+ + \text{O}_3^- \Rightarrow \text{O}_3 + \text{OH} + \text{H}$	10^{-7}	[3]
	434	$\text{H}_2\text{O}^+ + \text{NO}_3^- \Rightarrow \text{NO}_3 + \text{H}_2\text{O}$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	435	$\text{H}_2\text{O}^+ + \text{NO}_3^- \Rightarrow \text{NO}_3 + \text{OH} + \text{H}$	10^{-7}	[3]
H_2O	436	$\text{H}_2\text{O} + \text{N}_2^+ \Rightarrow \text{H}_2\text{O}^+ + \text{N}_2$	2.3×10^{-9}	[3]
N_2^+	437	$\text{N}_2^+ + \text{NO} \Rightarrow \text{NO}^+ + \text{N}_2$	3.9×10^{-10}	[3]
	438	$\text{N}_2^+ + \text{NO}^- \Rightarrow \text{NO} + \text{N}_2$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	439	$\text{N}_2^+ + \text{NO}^- \Rightarrow \text{NO} + 2\text{N}$	10^{-7}	[3]
	440	$\text{N}_2^+ + \text{O}_2 \Rightarrow \text{O}_2^+ + \text{N}_2$	5×10^{-11}	[3]
	441	$\text{N}_2^+ + \text{O}_2^- \Rightarrow \text{O}_2 + \text{N}_2$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	442	$\text{N}_2^+ + \text{O}_2^- \Rightarrow \text{O}_2 + 2\text{N}$	10^{-7}	[3]
	443	$\text{N}_2^+ + \text{N}_2\text{O} \Rightarrow \text{N}_2\text{O}^+ + \text{N}_2$	6×10^{-10}	[3]
	444	$\text{N}_2^+ + \text{N}_2\text{O} \Rightarrow \text{NO}^+ + \text{N} + \text{N}_2$	4×10^{-10}	[3]
	445	$\text{N}_2^+ + \text{N}_2\text{O}^- \Rightarrow \text{N}_2\text{O} + \text{N}_2$	$2 \times 10^{-7} (300/T_g)^{0.5}$	[3]
	446	$\text{N}_2^+ + \text{N}_2\text{O}^- \Rightarrow \text{N}_2\text{O} + 2\text{N}$	10^{-7}	[3]
	447	$\text{N}_2^+ + \text{NO}_2 \Rightarrow \text{NO}^+ + \text{N}_2\text{O}$	5×10^{-11}	[3]

	448	$N_2^+ + NO_2 \Rightarrow NO_2^+ + N_2$	3×10^{-10}	[3]
	449	$N_2^+ + NO_2^- \Rightarrow NO_2 + N_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	450	$N_2^+ + NO_2^- \Rightarrow NO_2 + 2N$	10^{-7}	[3]
	451	$N_2^+ + O_3^- \Rightarrow O_3 + N_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	452	$N_2^+ + O_3^- \Rightarrow O_3 + 2N$	10^{-7}	[3]
	453	$N_2^+ + O_3 \Rightarrow O_2^+ + O + N_2$	10^{-10}	[3]
	454	$N_2^+ + NO_3^- \Rightarrow NO_3 + N_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	455	$N_2^+ + NO_3^- \Rightarrow NO_3 + 2N$	10^{-7}	[3]
N ₂	456	$N_2^+(B^2\Sigma_u^+v0) \Rightarrow N_2^+ + hv(391.44nm)$	6.53×10^8	[11]
	457	$N_2^+(B^2\Sigma_u^+v0) \Rightarrow N_2^+(X^2\Sigma_g^+v1) + hv(427.81nm)$	6.34×10^8	[11]
	458	$N_2 + O_2^+ \Rightarrow NO^+ + NO$	10^{-17}	[3]
	459	$N_2 + O_2^- \Rightarrow N_2 + O_2 + e$	$1.9 \times 10^{-12}(T_g/300)^{0.5}\exp(-4990/T_g)$	[3]
	460	$N_2^+(B^2\Sigma_u^+v0) + N_2 \Rightarrow N_2^+ + N_2$	4.2×10^{-9}	[12]
	461	$N_2(C^3\Pi_uv0) \Rightarrow N_2(B^3\Pi_gv0) + hv(337.13nm)$	12.1×10^6	[13]
	462	$N_2(C^3\Pi_uv0) \Rightarrow N_2(B^3\Pi_gv1) + hv(357.69nm)$	8.6×10^6	[13]
	463	$N_2(C^3\Pi_uv0) \Rightarrow N_2(B^3\Pi_gv2) + hv(380.49nm)$	3×10^6	[13]
	464	$N_2(C^3\Pi_uv0) \Rightarrow N_2(B^3\Pi_gv3) + hv(405.94nm)$	10^6	[13]
	465	$N_2(C^3\Pi_uv1) \Rightarrow N_2(B^3\Pi_gv0) + hv(315.93nm)$	11×10^6	[13]
	466	$N_2(C^3\Pi_uv1) \Rightarrow N_2(B^3\Pi_gv2) + hv(353.67nm)$	5.2×10^6	[13]
	467	$N_2(C^3\Pi_uv1) \Rightarrow N_2(B^3\Pi_gv3) + hv(375.54nm)$	4.6×10^6	[13]
	468	$N_2(C^3\Pi_uv1) \Rightarrow N_2(B^3\Pi_gv4) + hv(399.85nm)$	2.4×10^6	[13]
	469	$N_2(C^3\Pi_uv2) \Rightarrow N_2(B^3\Pi_gv4) + hv(371.05nm)$	3.12×10^6	[13]
NO ⁺	470	$NO^+ + NO^- \Rightarrow 2NO$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	471	$NO^+ + NO^- \Rightarrow NO + N + O$	10^{-7}	[3]
	472	$NO^+ + O_2^- \Rightarrow O_2 + N + O$	10^{-7}	[3]
	473	$NO^+ + O_2^- \Rightarrow O_2 + NO$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	474	$NO^+ + N_2O^- \Rightarrow N_2O + NO$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	475	$NO^+ + N_2O^- \Rightarrow N_2O + N + O$	10^{-7}	[3]
	476	$NO^+ + NO_2^- \Rightarrow NO_2 + NO$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	477	$NO^+ + NO_2^- \Rightarrow NO_2 + N + O$	10^{-7}	[3]
	478	$NO^+ + O_3 \Rightarrow NO_2^+ + O_2$	10^{-15}	[3]
	479	$NO^+ + O_3^- \Rightarrow O_3 + N + O$	10^{-7}	[3]
	480	$NO^+ + O_3^- \Rightarrow O_3 + NO$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	481	$NO^+ + NO_3^- \Rightarrow NO_3 + NO$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	482	$NO^+ + NO_3^- \Rightarrow NO_3 + N + O$	10^{-7}	[3]
	483	$NO^+ + N_2O_5 \Rightarrow NO_2^+ + 2NO_2$	5.9×10^{-10}	[3]
NO	484	$NO + NO^- \Rightarrow 2NO + e$	5×10^{-12}	[3]
	485	$NO + O_2^+ \Rightarrow NO^+ + O_2$	4.6×10^{-10}	[3]
	486	$NO + HO_2 \Rightarrow OH + NO_2$	$3.4 \times 10^{-12}\exp(270/T_g)$	[3]
	487	$NO + HO_2 \Rightarrow O_2 + HNO$	$3.3 \times 10^{-13}\exp(-1000/T_g)$	[3]
	488	$NO + N_2O^+ \Rightarrow NO^+ + N_2O$	2.3×10^{-10}	[3]
	489	$NO + NO_2^+ \Rightarrow NO^+ + NO_2$	2.75×10^{-10}	[3]
	490	$NO + NO_2^- \Rightarrow NO^- + NO_2$	2.75×10^{-10}	[3]
	491	$NO + O_3 \Rightarrow NO_2 + O_2$	$1.8 \times 10^{-12}\exp(-1370/T_g)$	[3]
	492	$NO + O_3^- \Rightarrow NO_2^- + O_2$	10^{-11}	[3]
	493	$NO + O_3^- \Rightarrow NO_3^- + O$	10^{-11}	[3]
	494	$NO + NO_3 \Rightarrow 2NO_2$	$1.8 \times 10^{-11}\exp(110/T_g)$	[3]
	495	$NO + NO_3^- \Rightarrow NO_2^- + NO_2$	3×10^{-15}	[3]
NO ⁻	496	$NO^- + H_2 \Rightarrow NO + H_2 + e$	2.3×10^{-13}	[3]

	497	$\text{NO}^- + \text{M} \Rightarrow \text{NO} + \text{M} + \text{e}$	2.4×10^{-13}	[3]
	498	$\text{NO}^- + \text{O}_2^+ \Rightarrow \text{NO} + \text{O}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	499	$\text{NO}^- + \text{O}_2^+ \Rightarrow \text{NO} + 2\text{O}$	10^{-7}	[3]
	500	$\text{NO}^- + \text{O}_2 \Rightarrow \text{O}_2^- + \text{NO}$	5×10^{-10}	[3]
	501	$\text{NO}^- + \text{NO}_2^+ \Rightarrow \text{NO} + \text{NO}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	502	$\text{NO}^- + \text{NO}_2^+ \Rightarrow \text{NO} + \text{N} + \text{O}_2$	10^{-7}	[3]
	503	$\text{NO}^- + \text{O}_3 \Rightarrow \text{O}_3^- + \text{NO}$	3×10^{-10}	[3]
	504	$\text{NO}^- + \text{N}_2\text{O}^+ \Rightarrow \text{NO} + \text{N}_2\text{O}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	505	$\text{NO}^- + \text{N}_2\text{O}^+ \Rightarrow \text{NO} + \text{N}_2 + \text{O}$	10^{-7}	[3]
	506	$\text{NO}^- + \text{N}_2\text{O} \Rightarrow \text{NO} + \text{N}_2\text{O} + \text{e}$	5.1×10^{-12}	[3]
	507	$\text{NO}^- + \text{N}_2\text{O} \Rightarrow \text{NO}_2^- + \text{N}_2$	2.8×10^{-14}	[3]
	508	$\text{NO}^- + \text{NO}_2 \Rightarrow \text{NO}_2^- + \text{NO}$	3×10^{-10}	[3]
	509	$\text{NO}^- + \text{NO}_3 \Rightarrow \text{NO}_3^- + \text{NO}$	3×10^{-10}	[3]
O_2^+	510	$\text{O}_2^+ + \text{O}_2^- \Rightarrow 2\text{O}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[4]
	511	$\text{O}_2^+ + \text{O}_2^- \Rightarrow \text{O}_2 + 2\text{O}$	10^{-7}	[3]
	512	$\text{O}_2^+ + \text{N}_2\text{O}^- \Rightarrow \text{N}_2\text{O} + \text{O}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	513	$\text{O}_2^+ + \text{N}_2\text{O}^- \Rightarrow \text{N}_2\text{O} + 2\text{O}$	10^{-7}	[3]
	514	$\text{O}_2^+ + \text{NO}_2 \Rightarrow \text{NO}_2^+ + \text{O}_2$	6.6×10^{-10}	[3]
	515	$\text{O}_2^+ + \text{NO}_2 \Rightarrow \text{NO}^+ + \text{O}_3$	10^{-11}	[3]
	516	$\text{O}_2^+ + \text{NO}_2^- \Rightarrow \text{NO}_2 + \text{O}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	517	$\text{O}_2^+ + \text{NO}_2^- \Rightarrow \text{NO}_2 + 2\text{O}$	10^{-7}	[3]
	518	$\text{O}_2^+ + \text{O}_3^- \Rightarrow \text{O}_3 + \text{O}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	519	$\text{O}_2^+ + \text{O}_3^- \Rightarrow \text{O}_3 + 2\text{O}$	10^{-7}	[3]
	520	$\text{O}_2^+ + \text{NO}_3^- \Rightarrow \text{NO}_3 + \text{O}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	521	$\text{O}_2^+ + \text{NO}_3^- \Rightarrow \text{NO}_3 + 2\text{O}$	10^{-7}	[3]
	522	$\text{O}_2^+ + \text{N}_2\text{O}_5 \Rightarrow \text{NO}_2^+ + \text{NO}_3 + \text{O}_2$	8.8×10^{-10}	[3]
O_2	523	$\text{O}_2 + \text{O}_2^- \Rightarrow 2\text{O}_2 + \text{e}$	$2.7 \times 10^{-10}(T_g/300)^{0.5}\exp(-5590/T_g)$	[3]
	524	$\text{O}_2 + \text{N}_2\text{O}^+ \Rightarrow \text{NO}^+ + \text{NO}_2$	4.59×10^{-11}	[3]
	525	$\text{O}_2 + \text{N}_2\text{O}^+ \Rightarrow \text{O}_2^+ + \text{N}_2\text{O}$	2.24×10^{-10}	[3]
	526	$\text{O}_2 + \text{HNO} \Rightarrow \text{NO} + \text{HO}_2$	$5.25 \times 10^{-12}\exp(-1510/T_g)$	[3]
	527	$\text{O}_2 + \text{HNO} \Rightarrow \text{NO}_2 + \text{OH}$	1.66×10^{-15}	[3]
	528	$\text{O}_2 + \text{O}_3^- \Rightarrow \text{O}_3 + \text{O}_2 + \text{e}$	2.3×10^{-11}	[3]
HNO	529	$2\text{HNO} \Rightarrow \text{N}_2\text{O} + \text{H}_2\text{O}$	$1.4 \times 10^{-15}\exp(-1600/T_g)$	[3]
O_2^-	530	$\text{O}_2^- + \text{O}_3 \Rightarrow \text{O}_3 + \text{O}_2 + \text{e}$	6×10^{-10}	[3]
	531	$\text{O}_2^- + \text{O}_3 \Rightarrow \text{O}_3^- + \text{O}_2$	3.5×10^{-10}	[3]
	532	$\text{O}_2^- + \text{N}_2\text{O}^+ \Rightarrow \text{O}_2 + \text{N}_2\text{O}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	533	$\text{O}_2^- + \text{N}_2\text{O}^+ \Rightarrow \text{O}_2 + \text{N}_2 + \text{O}$	10^{-7}	[3]
	534	$\text{O}_2^- + \text{N}_2\text{O} \Rightarrow \text{O}_3^- + \text{N}_2$	10^{-11}	[3]
	535	$\text{O}_2^- + \text{NO}_2^+ \Rightarrow \text{O}_2 + \text{NO}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	536	$\text{O}_2^- + \text{NO}_2^+ \Rightarrow \text{O}_2 + \text{N} + \text{O}_2$	10^{-7}	[3]
	537	$\text{O}_2^- + \text{NO}_2 \Rightarrow \text{NO}_2^- + \text{O}_2$	7×10^{-10}	[3]
	538	$\text{O}_2^- + \text{NO}_3 \Rightarrow \text{NO}_3^- + \text{O}_2$	5×10^{-10}	[3]
	539	$\text{O}_2^- + \text{HNO}_3 \Rightarrow \text{NO}_3^- + \text{HO}_2$	2.8×10^{-10}	[3]
M	540	$\text{M} + \text{O}_3 \Rightarrow \text{O} + \text{O}_2 + \text{M}$	$3.92 \times 10^{-10}\exp(-11400/T_g)$	[3]
HO_2	541	$2\text{HO}_2 \Rightarrow \text{H}_2\text{O}_2 + \text{O}_2$	$2.2 \times 10^{-13}\exp(600/T_g)$	[3]
	542	$\text{HO}_2 + \text{O}_3 \Rightarrow \text{OH} + 2\text{O}_2$	$1.4 \times 10^{-14}\exp(-600/T_g)$	[3]
	543	$\text{HO}_2 + \text{NO}_3 \Rightarrow \text{NO}_2 + \text{OH} + \text{O}_2$	4.8×10^{-12}	[3]
	544	$\text{HO}_2 + \text{NO}_3 \Rightarrow \text{HNO}_3 + \text{O}_2$	9.2×10^{-13}	[3]
N_2O^+	545	$\text{N}_2\text{O}^+ + \text{N}_2\text{O} \Rightarrow \text{NO}^+ + \text{NO} + \text{N}_2$	1.2×10^{-11}	[3]
	546	$\text{N}_2\text{O}^+ + \text{N}_2\text{O}^- \Rightarrow 2\text{N}_2\text{O}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]

	547	$\text{N}_2\text{O}^+ + \text{N}_2\text{O}^- \Rightarrow \text{N}_2\text{O} + \text{N}_2 + \text{O}$	10^{-7}	[3]
	548	$\text{N}_2\text{O}^+ + \text{NO}_2 \Rightarrow \text{NO}^+ + \text{N}_2 + \text{O}_2$	4.29×10^{-10}	[3]
	549	$\text{N}_2\text{O}^+ + \text{NO}_2 \Rightarrow \text{NO}_2^+ + \text{N}_2\text{O}$	2.21×10^{-10}	[3]
	550	$\text{N}_2\text{O}^+ + \text{NO}_2^- \Rightarrow \text{NO}_2 + \text{N}_2\text{O}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	551	$\text{N}_2\text{O}^+ + \text{NO}_2^- \Rightarrow \text{NO}_2 + \text{N}_2 + \text{O}$	10^{-7}	[3]
	552	$\text{N}_2\text{O}^+ + \text{O}_3^- \Rightarrow \text{O}_3 + \text{N}_2\text{O}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	553	$\text{N}_2\text{O}^+ + \text{O}_3^- \Rightarrow \text{O}_3 + \text{N}_2 + \text{O}$	10^{-7}	[3]
	554	$\text{N}_2\text{O}^+ + \text{NO}_3^- \Rightarrow \text{NO}_3 + \text{N}_2\text{O}$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	555	$\text{N}_2\text{O}^+ + \text{NO}_3^- \Rightarrow \text{NO}_3 + \text{N}_2 + \text{O}$	10^{-7}	[3]
N_2O	556	$\text{N}_2\text{O} + \text{NO}_2^- \Rightarrow \text{NO}_3^- + \text{N}_2$	5×10^{-13}	[3]
N_2O^-	557	$\text{N}_2\text{O}^- + \text{NO}_2^+ \Rightarrow \text{N}_2\text{O} + \text{NO}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	558	$\text{N}_2\text{O}^- + \text{NO}_2^+ \Rightarrow \text{N}_2\text{O} + \text{N} + \text{O}_2$	10^{-7}	[3]
NO_2^+	559	$\text{NO}_2^+ + \text{NO}_2^- \Rightarrow 2\text{NO}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	560	$\text{NO}_2^+ + \text{NO}_2^- \Rightarrow \text{NO}_2 + \text{N} + \text{O}_2$	10^{-7}	[3]
	561	$\text{NO}_2^+ + \text{O}_3^- \Rightarrow \text{O}_3 + \text{NO}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	562	$\text{NO}_2^+ + \text{O}_3^- \Rightarrow \text{O}_3 + \text{N} + \text{O}_2$	10^{-7}	[3]
	563	$\text{NO}_2^+ + \text{NO}_3^- \Rightarrow \text{NO}_3 + \text{NO}_2$	$2 \times 10^{-7}(300/T_g)^{0.5}$	[3]
	564	$\text{NO}_2^+ + \text{NO}_3^- \Rightarrow \text{NO}_3 + \text{N} + \text{O}_2$	10^{-7}	[3]
NO_2	565	$\text{NO}_2 + \text{NO}_2^- \Rightarrow \text{NO}_3^- + \text{NO}$	4×10^{-12}	[3]
	566	$\text{NO}_2 + \text{O}_3 \Rightarrow \text{NO}_3 + \text{O}_2$	$1.4 \times 10^{-13}\exp(-2470/T_g)$	[3]
	567	$\text{NO}_2 + \text{O}_3^- \Rightarrow \text{NO}_2^- + \text{O}_3$	7×10^{-11}	[3]
	568	$\text{NO}_2 + \text{O}_3^- \Rightarrow \text{NO}_3^- + \text{O}_2$	2×10^{-11}	[3]
	569	$\text{NO}_2 + \text{NO}_3 \Rightarrow \text{NO}_2 + \text{NO} + \text{O}_2$	$2.3 \times 10^{-13}\exp(-1600/T_g)$	[3]
NO_2^-	570	$\text{NO}_2^- + \text{O}_3 \Rightarrow \text{NO}_3^- + \text{O}_2$	1.8×10^{-11}	[3]
	571	$\text{NO}_2^- + \text{NO}_3 \Rightarrow \text{NO}_3^- + \text{NO}_2$	5×10^{-10}	[3]
	572	$\text{NO}_2^- + \text{HNO}_3 \Rightarrow \text{NO}_3^- + \text{HNO}_2$	1.6×10^{-9}	[3]
	573	$\text{NO}_2^- + \text{N}_2\text{O}_5 \Rightarrow \text{NO}_3^- + \text{NO}_3 + \text{NO}$	7×10^{-10}	[3]
O_3	574	$\text{O}_3 + \text{O}_3^- \Rightarrow 3\text{O}_2 + \text{e}$	3×10^{-10}	[3]
O_3^-	575	$\text{O}_3^- + \text{NO}_3 \Rightarrow \text{NO}_3^- + \text{O}_3$	5×10^{-10}	[3]
HNO_2	576	$2\text{HNO}_2 \Rightarrow \text{NO} + \text{NO}_2 + \text{H}_2\text{O}$	10^{-20}	[3]
	577	$\text{HNO}_2 + \text{HNO}_3 \Rightarrow 2\text{NO}_2 + \text{H}_2\text{O}$	1.6×10^{-17}	[3]
NO_3	578	$2\text{NO}_3 \Rightarrow 2\text{NO}_2 + \text{O}_2$	$5 \times 10^{-12}\exp(-3000/T_g)$	[3]
Expansion	579-1226	RONs Absorptions of Photons List	See Figure	See Figure

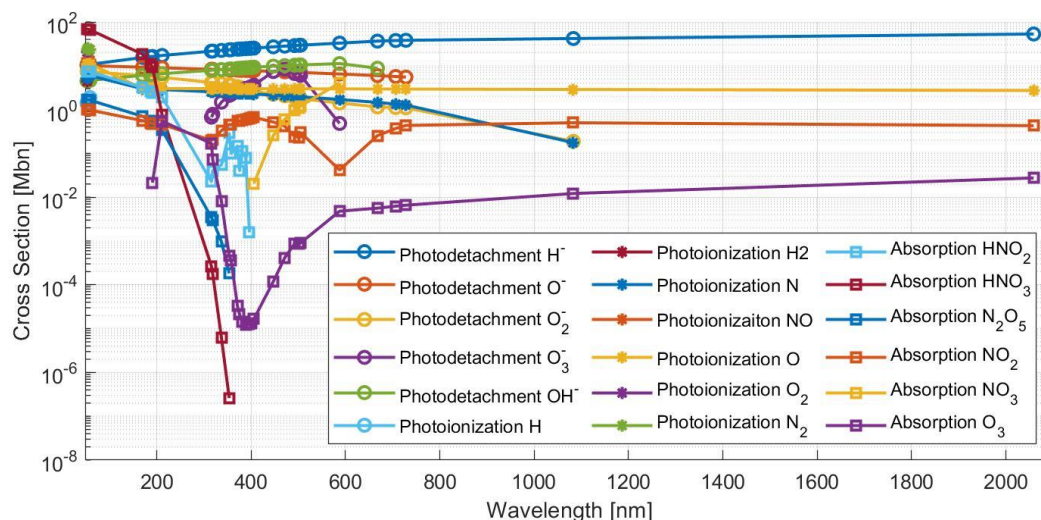
T_g and T_e are both in [K].

The rate coefficients of photon emissions are in [s^{-1}].

The rate coefficients of two-body collisions are in [cm^3/s], and the ones of three-body collisions are in [cm^6/s].

The species M represents He, N_2 , and O_2 which plays the major part of the mixture.

* For $T_e < 3.3$ eV, the value is 0.



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