Table 1: Considered reactions involving electrons. Rate constants were calculated using Bolsig+ software [**?**]. They are functions of $E/N$.

| | Reactions | Rate constants ($cm^3s^{-1}$ or $cm^6s^{-1}$) | Refs. |
|---|---|---|---|
| R1 | $e + N_2 \rightarrow e + N_2(J)$ | $f_1(E/N)$ | Phelps-0.02eV |
| R2 | $e + N_2 \rightarrow e + N_2(v)$ | $f_2(E/N)$ | Phelps-$(v_1 - v_8)$ |
| R3 | $e + N_2 \rightarrow e + N_2(A_1)$ | $f_3(E/N)$ | Phelps-6.17eV |
| R4 | $e + N_2 \rightarrow e + N_2(A_2)$ | $f_4(E/N)$ | Phelps-7.00eV |
| R5 | $e + N_2 \rightarrow e + N_2(B)$ | $f_5(E/N)$ | Phelps-7.35, 7.36, 7.80, 8.16eV |
| R6 | $e + N_2 \rightarrow e + N_2(a)$ | $f_6(E/N)$ | Phelps-8.40, 8.55, 8.89eV |
| R7 | $e + N_2 \rightarrow e + N_2(C)$ | $f_7(E/N)$ | Phelps-11.03eV |
| R8 | $e + N_2 \rightarrow e + N_2(E)$ | $f_8(E/N)$ | Phelps-11.87, 12.25eV |
| R9 | $e + N_2 \rightarrow e + N(^4S) + N(^2D)$ | $f_9(E/N)$ | Phelps-13eV |
| R10 | $e + O_2 \rightarrow e + O_2(J)$ | $f_{10}(E/N)$ | Phelps-0.02eV |
| R11 | $e + O_2 \rightarrow e + O_2(v)$ | $f_{11}(E/N)$ | Phelps-$(v_1 - v_4)$ |
| R12 | $e + O_2 \rightarrow e + O_2(a)$ | $f_{12}(E/N)$ | Phelps-0.977eV |
| R13 | $e + O_2 \rightarrow e + O_2(b)$ | $f_{13}(E/N)$ | Phelps-1.627eV |
| R14 | $e + O_2 \rightarrow e + O_2(A)$ | $f_{14}(E/N)$ | Phelps-4.5eV |
| R15 | $e + O_2 \rightarrow e + O(^3P) + O(^3P)$ | $f_{15}(E/N)$ | Phelps-6eV |
| R16 | $e + O_2 \rightarrow e + O(^3P) + O(^1D)$ | $f_{16}(E/N)$ | Phelps-8.4eV |
| R17 | $e + O_2 \rightarrow e + O(^3P) + O(^1S)$ | $f_{17}(E/N)$ | Phelps-9.97eV |
| R18 | $e + N_2 \rightarrow 2e + N_2^+$ | $f_{18}(E/N)$ | Phelps-15.6eV |
| R19 | $e + N_2 \rightarrow 2e + N_2^+$ | $f_{19}(E/N)$ | Phelps-18.8eV |
| R20 | $e + O_2 \rightarrow 2e + O_2^+$ | $f_{20}(E/N)$ | Phelps-12.06eV |
| R21 | $e + O_3 \rightarrow 2e + O_3^+$ | $f_{21}(E/N)$ | Morgan-12.43eV |
| R22 | $e + O(^3P) \rightarrow 2e + O^+$ | $f_{22}(E/N)$ | IST-Lisbon-13.6eV |
| R23 | $e + N(^4S) \rightarrow 2e + N^+$ | $f_{23}(E/N)$ | IST-Lisbon-14.54eV |
| R24 | $e + O_2 + O_2 \rightarrow O_2^- + O_2$ | $f_{24}(E/N)$ | Phelps |
| R25 | $e + O_2 \rightarrow O^- + O(^3P)$ | $f_{25}(E/N)$ | Phelps |

Table 2: Considered reactions involving charged particles. $T$ (K) and $T_e$ (K) are gas and electron temperatures, respectively.

| | Reactions | Rate constants ($cm^3s^{-1}$ or $cm^6s^{-1}$) | Refs. |
|---|---|---|---|
| R26 | $N_2(B) + N_2(B) \rightarrow e + N_4^+$ | $2.00 \times 10^{-10}$ | [?] |
| R27 | $N_2(a) + N_2(A_1) \rightarrow e + N_4^+$ | $5.00 \times 10^{-11}$ | [?] |
| R28 | $N_2(a) + N_2(A_2) \rightarrow e + N_4^+$ | $5.00 \times 10^{-11}$ | [?] |
| R29 | $N_2(a) + N_2(a) \rightarrow e + N_4^+$ | $2.00 \times 10^{-10}$ | [?] |
| R30 | $N(^2D) + O(^3P) \rightarrow e + NO^+$ | $1.00 \times 10^{-12}$ | [?] |
| R31 | $e + O(^3P) + O_2 \rightarrow O_2^- + O(^3P)$ | $1.00 \times 10^{-31}$ | [?] |
| R32 | $e + O(^3P) + O_2 \rightarrow O^- + O_2$ | $1.00 \times 10^{-31}$ | [?] |
| R33 | $e + O_3 \rightarrow O_2^- + O(^3P)$ | $1.00 \times 10^{-9}$ | [?] |
| R34 | $e + O_3 \rightarrow O^- + O_2$ | $1.00 \times 10^{-11}$ | [?] |
| R35 | $O_2^- + M \rightarrow e + O_2 + M$ | $1.24 \times 10^{-11} \exp(-(\frac{179}{8.8+E/N})^2)$ | [?] |
| R36 | $O^- + N_2 \rightarrow e + N_2O$ | $1.16 \times 10^{-12} \exp(-(\frac{48.9}{11+E/N})^2)$ | [?] |
| R37 | $O^- + O_2 \rightarrow e + O_3$ | $5.00 \times 10^{-15}$ | [?] |
| R38 | $O^- + O_2(a) \rightarrow e + O_3$ | $3.00 \times 10^{-10}$ | [?] |
| R39 | $O^- + O_2(b) \rightarrow e + O_2 + O(^3P)$ | $6.90 \times 10^{-10}$ | [?] |
| R40 | $O^- + N_2(A_1) \rightarrow e + N_2 + O(^3P)$ | $2.20 \times 10^{-9}$ | [?] |
| R41 | $O^- + N_2(B) \rightarrow e + N_2 + O(^3P)$ | $1.90 \times 10^{-9}$ | [?] |
| R42 | $O^- + O(^3P) \rightarrow e + O_2$ | $5.00 \times 10^{-10}$ | [?] |
| R43 | $O^- + N(^4S) \rightarrow e + NO$ | $2.60 \times 10^{-10}$ | [?] |
| R44 | $O_2^- + O_2(a) \rightarrow e + 2O_2$ | $2.00 \times 10^{-10}$ | [?] |
| R45 | $O_2^- + O_2(b) \rightarrow e + 2O_2$ | $3.60 \times 10^{-10}$ | [?] |
| R46 | $O_2^- + N_2(A_1) \rightarrow e + O_2 + N_2$ | $2.10 \times 10^{-9}$ | [?] |
| R47 | $O_2^- + N_2(B) \rightarrow e + O_2 + N_2$ | $2.50 \times 10^{-9}$ | [?] |
| R48 | $O_2^- + O(^3P) \rightarrow e + O_3$ | $1.50 \times 10^{-10}$ | [?] |
| R49 | $O_2^- + N(^4S) \rightarrow e + NO_2$ | $5.00 \times 10^{-10}$ | [?] |
| R50 | $O_3^- + O(^3P) \rightarrow e + 2O_2$ | $3.00 \times 10^{-10}$ | [?] |
| R51 | $O^- + O_2 \rightarrow O_2^- + O(^3P)$ | $6.96 \times 10^{-11} \exp(-(\frac{198}{5.6+E/N})^2)$ | [?] |
| R52 | $O^- + O_2 + M \rightarrow O_3^- + M$ | $1.10 \times 10^{-30} \exp(-(\frac{E/N}{65})^2)$ | [?] |
| R53 | $O^- + O_3 \rightarrow O_3^- + O(^3P)$ | $5.30 \times 10^{-10}$ | [?] |
| R54 | $O_2^- + O_2 + M \rightarrow O_4^- + M$ | $3.50 \times 10^{-31} (\frac{300}{T})$ | [?] |
| R55 | $O_2^- + O_3 \rightarrow O_3^- + O_2$ | $4.00 \times 10^{-10}$ | [?] |
| R56 | $O_2^- + O(^3P) \rightarrow O^- + O_2$ | $3.30 \times 10^{-10}$ | [?] |
| R57 | $O_3^- + O(^3P) \rightarrow O_2^- + O_2$ | $3.20 \times 10^{-10}$ | [?] |
| R58 | $N_2^+ + O_2 \rightarrow O_2^+ + N_2$ | $6.00 \times 10^{-11} (\frac{300}{T})^{0.5}$ | [?] |
| R59 | $N_2^+ + O_3 \rightarrow O_2^+ + N_2 + O(^3P)$ | $1.00 \times 10^{-10}$ | [?] |
| R60 | $N_2^+ + N_2 + M \rightarrow N_4^+ + M$ | $5.20 \times 10^{-29} (\frac{300}{T})^{2.2}$ | [?] |
| R61 | $N_2^+ + N_2(A_1) \rightarrow N_3^+ + N(^4S)$ | $3.00 \times 10^{-10}$ | [?] |
| R62 | $N_2^+ + O(^3P) \rightarrow O^+ + N_2$ | $1.00 \times 10^{-11} (\frac{300}{T})^{0.2}$ | [?] |
| R63 | $N_2^+ + O(^3P) \rightarrow NO^+ + N(^4S)$ | $1.30 \times 10^{-10} (\frac{300}{T})^{0.5}$ | [?] |
| R64 | $N_2^+ + N(^4S) + M \rightarrow N_3^+ + M$ | $9.00 \times 10^{-30} \exp(\frac{400}{T})$ | [?] |
| R65 | $N_2^+ + N(^4S) \rightarrow N^+ + N_2$ | $2.40 \times 10^{-15} T$ | [?] |
| R66 | $N_4^+ + O_2 \rightarrow O_2^+ + 2N_2$ | $2.50 \times 10^{-10}$ | [?] |
| R67 | $N_4^+ + N_2 \rightarrow N_2^+ + 2N_2$ | $10^{-14.6+0.0036(T-300)}$ | [?] |
| R68 | $N_4^+ + O(^3P) \rightarrow O^+ + 2N_2$ | $2.50 \times 10^{-10}$ | [?] |
| R69 | $N_4^+ + N(^4S) \rightarrow N^+ + 2N_2$ | $1.00 \times 10^{-11}$ | [?] |
| R70 | $O_2^+ + O_2 + M \rightarrow O_4^+ + M$ | $2.40 \times 10^{-30} (\frac{300}{T})^{3.2}$ | [?] |
| R71 | $O_2^+ + N_2 + N_2 \rightarrow N_2O_2^+ + N_2$ | $9.00 \times 10^{-31} (\frac{300}{T})^{2.0}$ | [?] |
| R72 | $O_2^+ + N_2 \rightarrow NO^+ + NO$ | $1.00 \times 10^{-17}$ | [?] |
| R73 | $O_2^+ + N(^4S) \rightarrow NO^+ + O(^3P)$ | $1.20 \times 10^{-10}$ | [?] |
| R74 | $O_4^+ + O_2 \rightarrow O_2^+ + 2O_2$ | $3.30 \times 10^{-6} (\frac{300}{T})^4 \exp(\frac{-5030}{T})$ | [?] |
| R75 | $O_4^+ + O_2(a) \rightarrow O_2^+ + 2O_2$ | $1.00 \times 10^{-10}$ | [?] |
| R76 | $O_4^+ + O_2(b) \rightarrow O_2^+ + 2O_2$ | $1.00 \times 10^{-10}$ | [?] |
| R77 | $O_4^+ + N_2 \rightarrow N_2O_2^+ + O_2$ | $4.61 \times 10^{-12} (\frac{T}{300})^{2.5} \exp(\frac{-2650}{T})$ | [?] |
| R78 | $O_4^+ + O(^3P) \rightarrow O_2^+ + O_3$ | $3.00 \times 10^{-10}$ | [?] |
| R79 | $N_2O_2^+ + O_2 \rightarrow O_4^+ + N_2$ | $1.00 \times 10^{-9}$ | [?] |
| R80 | $N_2O_2^+ + N_2 \rightarrow O_2^+ + 2N_2$ | $1.10 \times 10^{-6} (\frac{300}{T})^{5.3} \exp(\frac{-2357}{T})$ | [?] |

Table 2: (continued)

| | Reactions | Rate constants ($cm^3s^{-1}$ or $cm^6s^{-1}$) | Refs. |
|---|---|---|---|
| R81 | $e + e + N_2^+ \rightarrow e + N_2$ | $1.00 \times 10^{-19}(\frac{300}{T_e})^{4.5}$ | [?] |
| R82 | $e + N_2^+ + M \rightarrow N_2 + M$ | $6.00 \times 10^{-27}(\frac{300}{T_e})^{1.5}$ | [?] |
| R83 | $e + N_2^+ \rightarrow N(^4S) + N(^4S)$ | $2.80 \times 10^{-7}(\frac{300}{T_e})^{0.5}$ | [?] |
| R84 | $e + N_2^+ \rightarrow N(^4S) + N(^2D)$ | $2.00 \times 10^{-7}(\frac{300}{T_e})^{0.5}$ | [?] |
| R85 | $e + N_4^+ \rightarrow N_2 + N_2(C)$ | $2.00 \times 10^{-6}(\frac{300}{T_e})^{0.5}$ | [?] |
| R86 | $e + e + O_2^+ \rightarrow e + O_2$ | $1.00 \times 10^{-19}(\frac{300}{T_e})^{4.5}$ | [?] |
| R87 | $e + O_2^+ + M \rightarrow O_2 + M$ | $6.00 \times 10^{-27}(\frac{300}{T_e})^{1.5}$ | [?] |
| R88 | $e + O_2^+ \rightarrow O(^3P) + O(^3P)$ | $2.40 \times 10^{-7}(\frac{300}{T_e})^{0.7}$ | [?] |
| R89 | $e + O_2^+ \rightarrow O(^3P) + O(^1D)$ | $1.95 \times 10^{-7}(\frac{300}{T_e})^{0.7}$ | [?] |
| R90 | $e + O_4^+ \rightarrow 2O_2$ | $1.40 \times 10^{-6}(\frac{300}{T_e})^{0.5}$ | [?] |
| R91 | $e + O_4^+ \rightarrow O_2 + 2O(^3P)$ | $4.20 \times 10^{-6}(\frac{300}{T_e})^{0.48}$ | [?] |
| R92 | $e + O_4^+ \rightarrow O_2 + O(^3P) + O(^1D)$ | $4.20 \times 10^{-6}(\frac{300}{T_e})^{0.48}$ | [?] |
| R93 | $e + N_2O_2^+ \rightarrow N_2 + O_2$ | $1.30 \times 10^{-6}(\frac{300}{T_e})^{0.5}$ | [?] |
| R94 | $N_2^+ + O^- + M \rightarrow N_2O + M$ | $2.00 \times 10^{-25}(\frac{300}{T})^{2.5}$ | [?] |
| R95 | $N_2^+ + O^- + M \rightarrow N_2 + O(^3P) + M$ | $2.00 \times 10^{-25}(\frac{300}{T})^{2.5}$ | [?] |
| R96 | $N_2^+ + O^- \rightarrow N_2 + O(^3P)$ | $2.00 \times 10^{-7}(\frac{300}{T})^{0.5}$ | [?] |
| R97 | $N_2^+ + O^- \rightarrow 2N(^4S) + O(^3P)$ | $1.00 \times 10^{-7}$ | [?] |
| R98 | $N_2^+ + O_2^- + M \rightarrow N_2 + O_2 + M$ | $2.00 \times 10^{-25}(\frac{300}{T})^{2.5}$ | [?] |
| R99 | $N_2^+ + O_2^- \rightarrow N_2 + O_2$ | $2.00 \times 10^{-7}(\frac{300}{T})^{0.5}$ | [?] |
| R100 | $N_2^+ + O_2^- \rightarrow O_2 + 2N(^4S)$ | $1.00 \times 10^{-7}$ | [?] |
| R101 | $N_2^+ + O_3^- \rightarrow N_2 + O_3$ | $2.00 \times 10^{-7}(\frac{300}{T})^{0.5}$ | [?] |
| R102 | $N_2^+ + O_3^- \rightarrow O_3 + 2N(^4S)$ | $1.00 \times 10^{-7}$ | [?] |
| R103 | $N_4^+ + O^- \rightarrow 2N_2 + O(^3P)$ | $1.00 \times 10^{-7}$ | [?] |
| R104 | $N_4^+ + O_2^- \rightarrow 2N_2 + O_2$ | $1.00 \times 10^{-7}$ | [?] |
| R105 | $N_4^+ + O_3^- \rightarrow 2N_2 + O_3$ | $1.00 \times 10^{-7}$ | [?] |
| R106 | $O_2^+ + O^- + M \rightarrow O_3 + M$ | $2.00 \times 10^{-25}(\frac{300}{T})^{2.5}$ | [?] |
| R107 | $O_2^+ + O^- + M \rightarrow O_2 + O(^3P) + M$ | $2.00 \times 10^{-25}(\frac{300}{T})^{2.5}$ | [?] |
| R108 | $O_2^+ + O^- \rightarrow O_2 + O(^3P)$ | $2.00 \times 10^{-7}(\frac{300}{T})^{0.5}$ | [?] |
| R109 | $O_2^+ + O^- \rightarrow 3O(^3P)$ | $1.00 \times 10^{-7}$ | [?] |
| R110 | $O_2^+ + O_2^- + M \rightarrow 2O_2 + M$ | $2.00 \times 10^{-25}(\frac{300}{T})^{2.5}$ | [?] |
| R111 | $O_2^+ + O_2^- + O_2 \rightarrow 2O_2 + 2O(^3P)$ | $2.00 \times 10^{-25}(\frac{300}{T})^{2.5}$ | [?] |
| R112 | $O_2^+ + O_2^- \rightarrow 2O_2$ | $2.00 \times 10^{-7}(\frac{300}{T})^{0.5}$ | [?] |
| R113 | $O_2^+ + O_2^- \rightarrow O_2 + 2O(^3P)$ | $1.00 \times 10^{-7}$ | [?] |
| R114 | $O_2^+ + O_3^- \rightarrow O_2 + O_3$ | $2.00 \times 10^{-7}(\frac{300}{T})^{0.5}$ | [?] |
| R115 | $O_2^+ + O_3^- \rightarrow O_3 + 2O(^3P)$ | $1.00 \times 10^{-7}$ | [?] |
| R116 | $O_4^+ + O^- \rightarrow 2O_2 + O(^3P)$ | $1.00 \times 10^{-7}$ | [?] |
| R117 | $O_4^+ + O_2^- + O_2 \rightarrow 3O_2 + 2O(^3P)$ | $2.00 \times 10^{-25}(\frac{300}{T})^{2.5}$ | [?] |
| R118 | $O_4^+ + O_2^- \rightarrow 3O_2$ | $1.00 \times 10^{-7}$ | [?] |
| R119 | $O_4^+ + O_3^- \rightarrow 2O_2 + O_3$ | $1.00 \times 10^{-7}$ | [?] |

Table 3: Considered reactions for neutral species. $T$ (K) is gas temperature.

| | Reactions | Rate constants ($cm^3s^{-1}$ or $cm^6s^{-1}$) | Refs. |
|---|---|---|---|
| R120 | $N_2(A_1) + O_2 \rightarrow N_2 + O_2(b)$ | $7.50 \times 10^{-13}$ | [?] |
| R121 | $N_2(A_1) + O_2 \rightarrow N_2 + 2O(^3P)$ | $1.70 \times 10^{-12}$ | [?] |
| R122 | $N_2(A_1) + O_2 \rightarrow N_2O + O(^3P)$ | $7.80 \times 10^{-14}$ | [?] |
| R123 | $N_2(A_1) + N_2 \rightarrow 2N_2$ | $3.00 \times 10^{-16}$ | [?] |
| R124 | $N_2(A_1) + N_2(A_1) \rightarrow N_2 + N_2(B)$ | $7.70 \times 10^{-11}$ | [?] |
| R125 | $N_2(A_1) + N_2(A_1) \rightarrow N_2 + N_2(C)$ | $1.60 \times 10^{-10}$ | [?] |
| R126 | $N_2(A_1) + N_2(A_1) \rightarrow N_2 + N_2(E)$ | $1.00 \times 10^{-11}$ | [?] |
| R127 | $N_2(A_1) + O(^3P) \rightarrow N_2 + O(^3P)$ | $2.00 \times 10^{-11}$ | [?] |
| R128 | $N_2(A_1) + O(^3P) \rightarrow N_2 + O(^1S)$ | $3.00 \times 10^{-11}$ | [?] |
| R129 | $N_2(A_1) + O(^3P) \rightarrow NO + N(^2D)$ | $7.00 \times 10^{-12}$ | [?] |
| R130 | $N_2(A_1) + N(^4S) \rightarrow N_2 + N(^2P)$ | $5.00 \times 10^{-11}$ | [?] |
| R131 | $N_2(A_2) + N_2 \rightarrow 2N_2$ | $3.00 \times 10^{-16}$ | [?] |
| R132 | $N_2(A_2) + N_2 \rightarrow N_2 + N_2(A_1)$ | $1.00 \times 10^{-11}$ | [?] |
| R133 | $N_2(A_2) + O(^3P) \rightarrow N_2 + O(^3P)$ | $2.00 \times 10^{-11}$ | [?] |
| R134 | $N_2(A_2) + O(^3P) \rightarrow NO + N(^4S)$ | $7.00 \times 10^{-12}$ | [?] |
| R135 | $N_2(B) + O_2 \rightarrow N_2 + 2O(^3P)$ | $3.00 \times 10^{-10}$ | [?] |
| R136 | $N_2(B) + N_2 \rightarrow N_2 + N_2(A_1)$ | $1.00 \times 10^{-11}$ | [?] |
| R137 | $N_2(B) \rightarrow N_2(A_1) + h\nu$ | $1.10 \times 10^{5}$ | [?] |
| R138 | $N_2(a) + O_2 \rightarrow N_2 + O(^3P) + O(^1D)$ | $2.80 \times 10^{-11}$ | [?] |
| R139 | $N_2(a) + N_2 \rightarrow N_2 + N_2(B)$ | $2.40 \times 10^{-13}$ | [?] |
| R140 | $N_2(C) + O_2 \rightarrow N_2 + 2O(^3P)$ | $2.50 \times 10^{-10}$ | [?] |
| R141 | $N_2(C) + O_2 \rightarrow N_2 + O(^3P) + O(^1S)$ | $3.00 \times 10^{-10}$ | [?] |
| R142 | $N_2(C) + N_2 \rightarrow N_2 + N_2(B)$ | $1.00 \times 10^{-11}$ | [?] |
| R143 | $N_2(C) + N_2 \rightarrow N_2 + N_2(a)$ | $1.00 \times 10^{-11}$ | [?] |
| R144 | $N_2(C) \rightarrow N_2(B) + h\nu$ | $2.40 \times 10^{7}$ | [?] |
| R145 | $N_2(E) + N_2 \rightarrow N_2 + N_2(C)$ | $1.00 \times 10^{-11}$ | [?] |
| R146 | $N(^4S) + O_2 \rightarrow NO + O(^3P)$ | $9.70 \times 10^{-15} T^{1.01} \exp(\frac{-3120}{T})$ | [?] |
| R147 | $N(^4S) + O_3 \rightarrow NO + O_2$ | $2.00 \times 10^{-16}$ | [?] |
| R148 | $N(^4S) + O(^3P) + M \rightarrow NO + M$ | $1.76 \times 10^{-31} T^{-0.5}$ | [?] |
| R149 | $N(^4S) + N(^4S) + N_2 \rightarrow N_2 + N_2(A_1)$ | $1.38 \times 10^{-34} \exp(\frac{-500}{T})$ | [?] |
| R150 | $N(^4S) + N(^4S) + N_2 \rightarrow N_2 + N_2(A_2)$ | $1.38 \times 10^{-34} \exp(\frac{-500}{T})$ | [?] |
| R151 | $N(^4S) + N(^4S) + N_2 \rightarrow N_2 + N_2(B)$ | $2.40 \times 10^{-33}$ | [?] |
| R152 | $N(^4S) + N(^4S) + M \rightarrow N_2 + M$ | $8.27 \times 10^{-34} \exp(\frac{500}{T})$ | [?] |
| R153 | $N(^4S) + N(^2P) \rightarrow N(^4S) + N(^2D)$ | $1.80 \times 10^{-12}$ | [?] |
| R154 | $N(^2D) + O_2 \rightarrow NO + O(^3P)$ | $2.52 \times 10^{-12} \exp(\frac{-185}{T})$ | [?] |
| R155 | $N(^2D) + O_2 \rightarrow NO + O(^1D)$ | $7.37 \times 10^{-12} \exp(\frac{-185}{T})$ | [?] |
| R156 | $N(^2D) + N_2 \rightarrow N_2 + N(^4S)$ | $1.70 \times 10^{-14}$ | [?] |
| R157 | $N(^2D) + O(^3P) \rightarrow N(^4S) + O(^3P)$ | $3.30 \times 10^{-12} \exp(\frac{-260}{T})$ | [?] |
| R158 | $N(^2P) + O_2 \rightarrow NO + O(^3P)$ | $2.60 \times 10^{-12}$ | [?] |
| R159 | $N(^2P) + N_2 \rightarrow N_2 + N(^2D)$ | $2.00 \times 10^{-18}$ | [?] |

Table 3: (continued)

| | Reactions | Rate constants ($cm^3s^{-1}$ or $cm^6s^{-1}$) | Refs. |
|---|---|---|---|
| R160 | $O_2(a) + O_2 \rightarrow 2O_2$ | $2.20 \times 10^{-18}(\frac{T}{300})^{0.8}$ | [?] |
| R161 | $O_2(a) + O_3 \rightarrow 2O_2 + O(^3P)$ | $9.70 \times 10^{-13} \exp(\frac{-1564}{T})$ | [?] |
| R162 | $O_2(a) + N_2 \rightarrow O_2 + N_2$ | $3.00 \times 10^{-21}$ | [?] |
| R163 | $O_2(a) + O(^3P) \rightarrow O_2 + O(^3P)$ | $7.00 \times 10^{-16}$ | [?] |
| R164 | $O_2(a) + O(^1S) \rightarrow 3O(^3P)$ | $3.40 \times 10^{-11}$ | [?] |
| R165 | $O_2(a) + O(^1S) \rightarrow O_2(b) + O(^1D)$ | $3.60 \times 10^{-11}$ | [?] |
| R166 | $O_2(a) + O(^1S) \rightarrow O_2(A) + O(^3P)$ | $1.30 \times 10^{-10}$ | [?] |
| R167 | $O_2(a) + N(^4S) \rightarrow NO + O(^3P)$ | $2.00 \times 10^{-14} \exp(\frac{-600}{T})$ | [?] |
| R168 | $O_2(b) + O_2 \rightarrow O_2 + O_2(a)$ | $4.30 \times 10^{-22} T^{2.4} \exp(\frac{-241}{T})$ | [?] |
| R169 | $O_2(b) + O_3 \rightarrow 2O_2 + O(^3P)$ | $1.80 \times 10^{-11}$ | [?] |
| R170 | $O_2(b) + N_2 \rightarrow N_2 + O_2(a)$ | $4.90 \times 10^{-15} \exp(\frac{-253}{T})$ | [?] |
| R171 | $O_2(b) + O(^3P) \rightarrow O_2(a) + O(^3P)$ | $8.00 \times 10^{-14}$ | [?] |
| R172 | $O_2(b) + O(^3P) \rightarrow O_2 + O(^1D)$ | $3.39 \times 10^{-11}(\frac{300}{T})^{0.1} \exp(\frac{-4201}{T})$ | [?] |
| R173 | $O_2(A) + O_2 \rightarrow 2O_2(b)$ | $2.90 \times 10^{-13}$ | [?] |
| R174 | $O_2(A) + N_2 \rightarrow N_2 + O_2(b)$ | $3.00 \times 10^{-13}$ | [?] |
| R175 | $O_2(A) + O(^3P) \rightarrow O_2(b) + O(^1D)$ | $9.00 \times 10^{-12}$ | [?] |
| R176 | $O(^3P) + O_2 + O_2 \rightarrow O_3 + O_2$ | $6.00 \times 10^{-34}(\frac{300}{T})^{2.6}$ | [?] |
| R177 | $O(^3P) + O_2 + N_2 \rightarrow O_3 + N_2$ | $5.60 \times 10^{-34}(\frac{300}{T})^{2.6}$ | [?] |
| R178 | $O(^3P) + O_3 \rightarrow 2O_2$ | $8.00 \times 10^{-12} \exp(\frac{-2060}{T})$ | [?] |
| R179 | $O(^3P) + O(^3P) + O_2 \rightarrow 2O_2$ | $2.45 \times 10^{-31} T^{-0.63}$ | [?] |
| R180 | $O(^3P) + O(^3P) + N_2 \rightarrow O_2 + N_2$ | $2.76 \times 10^{-34} \exp(\frac{720}{T})$ | [?] |
| R181 | $O(^3P) + O(^1D) + N_2 \rightarrow O_2 + N_2$ | $9.90 \times 10^{-33}$ | [?] |
| R182 | $O(^3P) + O(^1S) \rightarrow O(^3P) + O(^1D)$ | $5.00 \times 10^{-11} \exp(\frac{-301}{T})$ | [?] |
| R183 | $O(^1D) + O_2 \rightarrow O_2 + O(^3P)$ | $3.12 \times 10^{-11} \exp(\frac{70}{T})$ | [?] |
| R184 | $O(^1D) + O_2 \rightarrow O_2(b) + O(^3P)$ | $2.56 \times 10^{-11} \exp(\frac{67}{T})$ | [?] |
| R185 | $O(^1D) + O_3 \rightarrow 2O_2$ | $2.37 \times 10^{-10} \exp(\frac{6}{T})$ | [?] |
| R186 | $O(^1D) + O_3 \rightarrow O_2 + 2O(^3P)$ | $2.37 \times 10^{-10} \exp(\frac{6}{T})$ | [?] |
| R187 | $O(^1D) + N_2 \rightarrow N_2 + O(^3P)$ | $2.10 \times 10^{-11} \exp(\frac{115}{T})$ | [?] |
| R188 | $O(^1S) + O_2 \rightarrow O_2 + O(^1D)$ | $1.33 \times 10^{-12} \exp(\frac{-850}{T})$ | [?] |
| R189 | $O(^1S) + O_2 \rightarrow O_2(A) + O(^3P)$ | $2.97 \times 10^{-12} \exp(\frac{-850}{T})$ | [?] |
| R190 | $O(^1S) + O_3 \rightarrow 2O_2$ | $2.90 \times 10^{-10}$ | [?] |
| R191 | $O(^1S) + O_3 \rightarrow O_2 + O(^3P) + O(^1D)$ | $2.90 \times 10^{-10}$ | [?] |
| R192 | $O_3 + O_3 \rightarrow O_2 + O_3 + O(^3P)$ | $7.16 \times 10^{-10} \exp(\frac{-11200}{T})$ | [?] |

Table 4: Effective electronic states of $N_2$ and $O_2$ considered in the simulation.

| Electronic states | Excitation energy (eV) | Effective states |
|---|---|---|
| $N_2(X,\, v = 0)$ | 0 | $N_2$(X) |
| $N_2(A^3\Sigma_u^+,\, v = 0...4)$ | 6.17 | $N_2(A_1)$ |
| $N_2(A^3\Sigma_u^+,\, v = 5...9)$ | 7.00 | $N_2(A_2)$ |
| $N_2(B^3\Pi_g)$ | 7.35 | $N_2$(B) |
| $N_2(W^3\Delta_u)$ | 7.36 | $N_2$(B) |
| $N_2(A^3\Sigma_u^+,\, v > 10)$ | 7.80 | $N_2$(B) |
| $N_2(B'^3\Sigma_u^-)$ | 8.16 | $N_2$(B) |
| $N_2(a'^1\Sigma_u^-)$ | 8.40 | $N_2$(a) |
| $N_2(a^1\Pi_g)$ | 8.55 | $N_2$(a) |
| $N_2(w^1\Delta_u)$ | 8.89 | $N_2$(a) |
| $N_2(C^3\Pi_u)$ | 11.03 | $N_2$(C) |
| $N_2(E^3\Sigma_g^+)$ | 11.87 | $N_2$(E) |
| $N_2(a''^1\Sigma_g^+)$ | 12.25 | $N_2$(E) |
| $O_2(a^1\Delta_g)$ | 0.977 | $O_2$(a) |
| $O_2(b^1\Sigma_g^+)$ | 1.627 | $O_2$(b) |
| $O_2(c^1\Sigma_u^-)$ | 4.05 | $O_2$(A) |
| $O_2(A'^3\Delta_u)$ | 4.26 | $O_2$(A) |
| $O_2(A^3\Sigma_u^+)$ | 4.34 | $O_2$(A) |