Appendix B. Nomenclature

Acronyms

Abl	Full ablating surface-chemistry model
AblBwCstT	Ablation blowing (same mass flow as in the Abl case but without the surface chemistry) and constant temperature
ASBC	Ablating stability boundary condition (full surface chemistry model)
ATSBC	Ablating isothermal stability boundary condition (without the linearised surface energy balance)
BEW	Blottner-Eucken-Wilke transport model
BL	Boundary layer
CE	Chapman & Enskog's transport model
CNE	Chemical non-equilibrium (yet in chemical equilibrium)
CNE5	Gas in chemical non-equilibrium with five species (N, O, NO, N_2, O_2)
CNE6	Gas in chemical non-equilibrium with six species (CO_2, N, O, NO, N_2, O_2)
CNE11	Gas in chemical non-equilibrium with eleven species (C_3, CO_2, C_2, CO, CN, C, N, O, NO, N_2, O_2)
CPG	Calorically perfect gas
cstSc	Constant-Schmidt-number diffusion model
DNS	Direct numerical simulations
ISA	International Standard Atmosphere
LPSE	Linear parabolised stability equations
LST	Linear stability theory
LTE	Local thermochemical equilibrium
noBw	No blowing
RESBC	Radiative-equilibrium stability boundary condition
RRHO	Rigid rotor and harmonic oscillator thermal model
SM	Stefan-Maxwell diffusion theory
SSBw	Self-similar blowing (constant $\bar{f}_w$)
TCNE	Thermo-chemical non-equilibrium
TNE	Thermal non-equilibrium (yet frozen chemistry)
TPG	Thermally perfect gas (frozen)
TPG1	Thermally perfect (and frozen) gas with one species (23.65% O_2, 76.35% N_2 in mass).
TPG6	Thermally perfect (and frozen) gas with six species (CO_2, N, O, NO, N_2, O_2)
TPG11	Thermally perfect (and frozen) gas with eleven species (C_3, CO_2, C_2, CO, CN, C, N, O, NO, N_2, O_2)
TPS	Thermal protection system

Roman Symbols

$A_{B^*_{s\ell}}, \cdots, F_{B^*_{s\ell}}$	Polynomial curve-fit coefficients for collision integral ratios $B^*_{s\ell}$ [–]
A^μ_s, B^μ_s, C^μ_s	Coefficients in Blottner's viscosity curve fits [–]
A^f_r	Arrhenius pre-exponential constant (for property Q) [[Q] K$^{-n_{Tr}}$]
$A_{\Omega^{(i,j)}_{s\ell}}, \cdots, F_{\Omega^{(i,j)}_{s\ell}}$	Polynomial curve-fit coefficients for collision integral $\Omega^{(i,j)}_{s\ell}$ [–]
$B^*_{s\ell}$	Ratio of collision integrals (Eq. A 16) [–]
c_p	Heat capacity at constant p [J/kg-K]
c_v	Heat capacity at constant volume [J/kg-K]

d_s^j	Species diffusion driving force [1/m]
$\mathcal{D}_{\text{eff}}$	Effective diffusion coefficient [m^2/s]
$\mathcal{D}_{s\ell}$	Multicomponent diffusion coefficient of species s in species ℓ [m^2/s]
$\mathscr{D}_{s\ell}$	Binary diffusion coefficient of the species pair $s-\ell$ [m^2/s]
e	Internal energy [J/kg]
F	Perturbation frequency [Hz]
f_w	Self-similar blowing parameter (Eq. 4.1) [–]
g^{ij}	Contravariant metric tensor $\left(= (g_{ij})^{-1}\right)$ [–]
g_{ij}	Covariant metric tensor ($=\delta_{ij}$ for Cartesian coordinate system) [–]
$G_{s\ell}^{\kappa_H}$	Heavy-particle translational thermal conductivity matrix subsystem [K m/W]
$G_{s\ell}^{\mu}$	Viscosity matrix subsystem [m s/kg]
g_{sm}^{Elec}	Degeneracy of the m-th electronic energy level of species s [–]
g_{sm}^{Vib}	Degeneracy of the m-th vibrational mode of species s [–]
$\hbar$	Planck's constant ($= 6.626070040 \cdot 10^{-34}$) [J s]
$\mathcal{H}$	Set of all heavy species (not electrons) [–]
h	Static enthalpy per unit mass [J/kg]
$h_{f\,s}^{\circ}$	Species formation enthalpy at 0K [J/kg]
$H_{f\,s}^{298\,\text{K}}$	Species formation enthalpy at 298K [J/mol]
h^u	Total enthalpy per unit mass $\left(= h + 0.5\,u^2\right)$ [J/kg]
$i,\ j,\ k,\ l$	Sub- and super-indices corresponding to the spatial directions in co- or contravariant variables the tensorial notation. Other indices **do not correspond to tensorial directions**. [–]
$\mathcal{J}^j$	Energy diffusion flux [J/m^2-s]
J_s^j	Mass diffusion flux of species s [kg/m^2-s]
k_B	Boltzmann's constant ($= 1.38064852 \cdot 10^{-23}$) [m^2-kg/K-s^2]
$k_{b\,r}$	Backward reaction rate [(m^3/mol)$^{\sum_s \nu''_{sr}-1}$ s^{-1}]
$K_{\text{eq}\,r}$	Chemical equilibrium constant [(m^3/mol)$^{\sum_s \nu'_{sr}-\nu''_{sr}}$]
$k_{f\,r}$	Forward reaction rate [(m^3/mol)$^{\sum_s \nu'_{sr}-1}$ s^{-1}]
$k_{f\,r}^{\text{Oxid}}$	Reaction rate of the surface oxidation reactions [(m^3/mol)$^{\sum_\ell \nu'_{\ell r}-1}$ m/s]
$\mathcal{L}_s$	Molecule's linearity factor (3 for non-linear and 2 for linear) [–]
$\dot{m}_{s\,w}^{\text{Oxid}}$	Species mass production rate per unit mass due to oxidation reactions [kg/s-m^2]
$\mathscr{M}$	Molar mass [kg/mol]
$\mathscr{M}_r^{\text{Oxid}}$	Molar mass of the oxidizer in an oxidation reaction [kg/mol]
$\dot{m}_{s\,w}^{\text{Subl}}$	Species mass production rate per unit mass due to sublimation reactions [kg/s-m^2]
n	Number density [particle/m^3]
N_A	Avogadro's number ($= 6.022140857 \cdot 10^{23}$) [particles/mol]
n_{Tr}^f	Arrhenius temperature exponential constant [–]
p	Pressure [Pa]
P_s^{Vap}	Coefficient in the expression for the species vapor pressure (Eq. A 37) [K]
p_s^{Vap}	Vapor pressure of each species (Eq. A 37) [Pa]
$\mathcal{Q}$	Partition function [–]
Q_s^{Vap}	Coefficient in the expression for the species vapor pressure (Eq. A 37) [–]
R	Mixture-specific gas constant ($= \mathscr{R}/\mathscr{M}$) [J/kg-K]

$\mathcal{R}$	Set of all reactions [–]
$\mathcal{R}^{\text{Oxid}}$	Set of all oxidation reactions (Eq. A 30) [–]
$\mathscr{R}$	Universal gas constant (= 8.31447) [J/mol-K]
Sc	Schmidt number (Eq. A 13) [–]
$\mathcal{S}$	Set of all species [–]
$\mathcal{S}_{\text{mol}}$	Set of all molecular species [–]
$\mathcal{S}_{\text{Subl}}$	Set of all sublimating species (Eq. A 35) [–]
$\mathbb{T}^{ij}$	Viscous stress tensor [Pa]
T	Temperature [K]
t	Time [s]
$\mathscr{U}^j$	Velocity components in a Cartesian reference system [m]
u^j	Velocity components in tensorial notation [m/s]
$\mathscr{X}^j$	Spatial coordinates in a Cartesian reference system [m]
x^j	Spatial coordinates in tensorial notation [m]
X_s	Mole fraction of species s ($= Y_s\mathscr{M}/\mathscr{M}_s$) [–]
x, y, z	Spatial coordinates [m]
y_i	Wall-normal mapping parameter in Malik's mapping (Eq. 5.1) [m]
Y_s	Mass fraction of species s ($= \rho_s/\rho$) [–]
Greek Symbols	
α	Perturbation streamwise wavenumber [1/m]
α_r^{Oxid}	Reaction probability of an oxidation reaction (Eq. A 32) $[(\text{m}^3/\text{mol})^{\sum_\ell \nu'_{\ell r}-1}]$
α_s^{Subl}	Coefficient in the Knudsen-Langmuir equation (Eq. A 36) [–]
β	Perturbation spanwise wavenumber [1/m]
δ_{ab}	Dirac's discrete delta function (1 for $a = b$, 0 otherwise) [–]
ϵ_{C}	Emisivity of graphite (≈ 0.9) [–]
ϕ^μ	Mixing coefficient in Wilke's rule [–]
γ	Ratio of specific heats ($= c_p/c_v$) [–]
Γ_{ik}^j	Christoffel symbol of the second kind (Eq. 2.3) $[1/[x^k]]$
θ_{sm}^{Elec}	Activation temperature of the m-th electronic energy level of species s [K]
θ_r^f	Arrhenius activation temperature of reaction r [K]
θ_s^{Rot}	Rotational activation temperature [K]
θ_{sm}^{Vib}	Activation temperature of the m-th vibrational mode of species s [K]
κ^{Fr}	Frozen thermal conductivity [W/K-m]
λ	Second viscosity coefficient [kg/m-s]
μ	Dynamic viscosity [kg/m-s]
ν'_{sr}, ν''_{sr}	Stoichiometric coefficient for reactants & products s in reaction r [–]
ρ	Mass density [kg/m^3]
σ_s	Molecule's steric factor (2 for symmetric, 1 for non-symmetric) [–]
σ^{SB}	Stefan-Boltzmann constant $\left(= 5.67036713 \cdot 10^{-8}\right)$ [W/m^2-K^4]
ω	Perturbation frequency [1/s]
$\Omega_{s\ell}^{(i,j)}$	Collision integral of order (i, j) between species s and ℓ [m^2]
$\dot{\omega}_{\text{rad}}$	Surface radiative heat flux (Eq. 3.7) [W/m^2]
$\dot{\omega}_s$	Species production rate [kg/m^3-s]
Sub- and superscripts	
q	Total flow quantity
$\bar{q}$	Laminar base-flow quantity

q'	Perturbation quantity
$\tilde{q}$	Perturbation amplitude quantity
$q_{\Re}$	Real part of a complex variable
$q_{\Im}$	Imaginary part of a complex variable
q^i	Contravariant vector quantity
q^{ij}	Contravariant tensor quantity
q_i	Covariant vector quantity
q_{ij}	Covariant tensor quantity
$q_{,i}$	Covariant derivative of a quantity
q_e	Boundary-layer-edge quantity
q^{Mod}	Referred to the different energy modes
q_r	Reaction quantity
q_s, q_ℓ	Species-specific quantity
$q_{s\ell}$	Species-pair-specific quantity