

ERRATA — SECOND EDITION

Principles of Plasma Discharges and Materials Processing
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Front Matter:

p. xxxiv: Loschmidt's number $2.6868 \times 10^{25} \text{ m}^{-3}$ is defined at 0° C and 1 atm;
the perfect gas density at STP (25° C , 1 atm) is $n^\circ = 2.4615 \times 10^{25} \text{ m}^{-3}$.

Chapter 1:

p. 19, Fig. 1.14: Add labels (a)–(d).
p. 22, line 4: “ $T = 0.026 \text{ V}$ ” should be “ $T = 0.026 \text{ V}$ ”.

Chapter 2:

p. 29, line 6: “ $a_x v dv_x / dt$ ” should be “ $a_x = dv_x / dt$ ”.
p. 32, Eq. (2.3.14): remove “.” (period) from the equation.
p. 37, equation above Eq. (2.4.12): “ $4\pi g(W) dW$ ” should be “ $g(W) dW$ ”;
Eq. (2.4.12): “ $v(W)$ ” should be “ $4\pi v(W)$ ”.

Chapter 3:

p. 54, Eq. (3.2.25): “ C ” should be “ Ci ”.
p. 55, footnote: “ $= l$ ” should be “ $= (l - 1)$ ”.
p. 74, Eq. (3.4.24): delete the second “(at rest)”;
Eq. (3.4.30): “ m_{A+} ” should be “ m_R ”;
add “with m_R the reduced mass.” after Eq. (3.4.30).
p. 75, line 3: “(3.4.7)” should be “(3.4.6)”;
Eq. (3.4.31): “ m_{A+} ” should be “ m_R ”.

Chapter 4:

p. 99, Eq. (4.2.34): “ μ_0 ” should be “ $\mu_0 \tilde{\mathbf{E}}$ ”.
p. 101, line 12: “(4.2.23)” should be “(4.2.24)”.
p. 106, Eq. (4.3.17): “ $\frac{\partial B_x}{\partial z}$ ” should be “ $\frac{\partial B_x}{\partial z} \hat{x}$ ”.
p. 109, Eq. (4.3.29): “ ϵ_0 ” should be “ $\epsilon_0 \mu_0$ ”.
p. 111, Eq. (4.4.1b): “ $-\omega_{ce}$ ” should be “ $+\omega_{ce}$ ”.
p. 119, Eq. (4.5.20): “ $\omega_{ce} \omega_{ce}$ ” should be “ $\omega_{ce} \omega_{ci}$ ”.
p. 124, Eq. (4.6.4) (two occurrences): “ k_0 ” should be “ $-k_0$ ”.

Chapter 5:

p. 143, Eq. (5.2.38): “ $\frac{v_{iz}^2}{D^2}$ ” should be “ $\frac{v_{iz}}{D}$ ”.

- p. 144, 2nd line from the last: “to obtain” should be “obtain”.
- p. 147, 1st line after *Heuristic Solutions*: “(5.3.23)” should be “(5.3.7)”.
- p. 159, lines 5 and 6: “Fig. 12.10” should be “Fig. 12.12”; “(10.2.2)” should be “(10.2.15)”.
- p. 162, Problem 5.7: “(5.2.22)” should be “(5.2.29)”.

Chapter 6:

- p. 170, Eq. (6.2.11): “ $\frac{du_i}{dx}$ ” should be “ $n \frac{du_i}{dx}$ ”.
- p. 171, Figure caption: “ T_c ” should be “ T_e ”;
bottom equation: “ $2\Phi_p$ ” should be “ $-2\Phi_p$ ”.
- p. 174, 3rd line from bottom: “ 5×10^{-8} s” should be “ 4×10^{-8} s”.
- p. 175, last line before Section 6.3: “Figure 2.2” should be “Figure 1.11f”.
- p. 176, Eq. (6.3.11): “ $-\Phi$ ” should be “ $(-\Phi)$ ”.
- p. 177, line 12: “ $E = d\Phi/dx$ ” should be “ $E = -d\Phi/dx$ ”.
- p. 195, 5th line of 2nd paragraph: “all to easy” should be “all too easy”.
- p. 197, Eq. (6.6.36): “ $[1 + \frac{(V_B - \Phi_p)^{1/2}}{T_e}]$ ” should be “ $[1 + \frac{(V_B - \Phi_p)}{T_e}]^{1/2}$ ”.
- p. 198, 6th line from bottom: “Section 6.4” should be “Section 6.5”.
- p. 201, 3rd line after Eq. (6.6.39): “ $R_L \ll \partial I / \partial V_B$ ” should be “ $R_L \ll \partial V_B / \partial I$ ”;
9th and 10th lines after Eq. (6.6.39): “ $V_0 = 0$,” should be “ $I = 0$, we take $V_0 = 0$ ”;
delete “it then also improves accuracy to”.
- p. 204, Problem 6.4b: “ $\nu_{mi} = u_B / \lambda_i$.” should be “average $\nu_{mi} = u_B / \lambda_i$ for ions within the sheath, with an ion speed entering the sheath given by (6.2.20)”.

Chapter 7:

- p. 214, lines 10 and 11; and p. 218, 4th line from bottom: “K mol” should be “K·mol”.
- p. 221, line 4: add a space between “gas,” and “to obtain”;
3rd line after Eq. (7.3.31): “ $\mu_j^e = \mu_j$ ” should be “ $\mu_j = \mu_j^e$ ”.
- p. 224, 1st two lines after the table: “(7.4.9)” and “(7.4.10)” should be exchanged.
- p. 230, 1st line after Eq. (7.5.16): “2.69” should be “2.46”;
2nd line after Eq. (7.5.16): delete “(Loschmidt’s number)”.
- p. 232, 2nd line from the bottom: “K cm³” should be “K·cm³”.

Chapter 8:

- p. 244, line 11: “atom” should be “molecule”.
- p. 253, 2nd line from bottom above Section 8.4: “ $1/r^3$ potential” should be “ $1/r^2$ potential”.
- p. 258, 7th line from the last: “state 2” should be “state 3”.
- p. 263, Eq. (8.4.13), 2nd term in brackets: “ $Cp_d \left(\frac{2}{\pi kT}\right)^{1/2}$ ” should be “ $Cp_d \left(\frac{1}{2\pi^2 \epsilon_0 kT}\right)^{1/2}$ ”.
- p. 264, line 5: “ $p_d / \alpha_d^{1/2}$ ” should be “ $p_d / \alpha_p^{1/2}$ ”.

p. 269, right hand sides of 3rd and 4th reactions: “B*” should be “B+”.

Chapter 9:

p. 302, top of the page: add the line “ $\sim a_{\text{eff}}$. An electron with energy \mathcal{E}_e can”.

p. 312, 4th line after Eq. (9.4.3): “(9.4.2)” should be “(9.4.1)”.

p. 313, line after Eq. (9.4.9): “over l ” should be “over $(-l/2, l/2)$ ”.

p. 314, line after Eq. (9.4.11): “(5.2.10)” should be “the equation after (5.2.10)”;

Eq. (9.4.12): “ $(2 - \gamma)$ ” should be “ $2(2 - \gamma)$ ”.

Chapter 10:

p. 329, last line of 3rd paragraph: “Section 10.5” should be “Section 10.6”.

p. 317, unnumbered equation for AS(g) immediately above Eq. (9.4.29): “ K_d ” should be “ K_r ”.

p. 345, 3rd line after Eq. (10.3.16): “Section 10.4” should be “Section 10.5”.

p. 346, equation after Eq. (10.3.20): “ $T_i n_e E + T_i n_- E$ ” should be “ $-n_e E/T_i - n_- E/T_i$ ”;

line 8: “(10.3.14)” should be “(10.3.21)”.

p. 350, 4th line after Eq. (10.3.37): “(10.3.26)” should be “(10.3.36)”.

p. 355, Eq. (10.4.18): “ K_{iz} ” should be “ $K_{iz} n_g$ ”.

p. 356, Eq. (10.4.24): “ $\frac{8}{15} \alpha_0$ ” should be “ $\frac{8}{15} \alpha_0^2$ ”.

p. 357, Eq. (10.4.27): multiply the right hand side term by “ x ”;

Eq. (10.4.29): with the diffusion coefficient having the form (5.1.6), “ 8^2 ” should be “ 8π ”.

p. 359, Eq (10.4.36): “ $K_{iz} n_{e0}$ ” should be “ $K_{iz} n_{e0} n_g$ ”;

last line above Section 10.5: “Problem 10.15” should be “Problem 10.14”.

p. 361, 4th line from bottom: “43 mTorr” should be “45 mTorr”.

p. 367, 2nd line from the bottom: “(11.2.48)” should be “(11.2.49)”.

p. 380, Eq. (10.6.31): “ $(K_{\text{diss}} n_e n_{a0} + \nu_{\text{loss}})$ ” should be “ $(K_{\text{diss}} n_e + \nu_{\text{loss}})$ ”.

p. 382, Problem 10.2(c), 2nd line: “(10.2.9)” should be “(10.2.4)”.

p. 384, Problem 10.13, 4th line: “12, and 22” should be “and 12”.

Chapter 11:

p. 396, 1st line: “(10.2.7)” should be “(10.2.12)”.

p. 404, Eq. (11.2.19): “ $-\frac{\pi}{4}$ ” should be “ $\frac{\pi}{4}$ ”.

p. 406, Eq. (11.2.28): “ u_0 ” should be “ $-u_0$ ”;

1st line after Eq. (11.2.29): “plus” should be “minus”, and “minus” should be “plus”.

p. 408, 2nd line above *Example 1*: “(11.2.38)” should be “(11.2.35)”,

and “(10.2.5)” should be “(10.2.1)”.

p. 412, Eq. (11.2.58): “0.59” should be “0.49”.

- p. 414, 1st line below Eq. (11.2.62): “collisionless sheath” should be “collisionless ion sheath”;
 Eq. (11.2.63a): “ $2e$ ” should be “ $2\pi e$ ” (an error in Misium et al, 1989).
- p. 419, 6th line from the bottom: “Section 11.6” should be “Section 11.8”.
- p. 420, 3rd line: “(11.2.46)” should be “(11.2.47)”;
 5th line: “(11.2.44)” should be “(11.2.45)”;
 6th line: “(11.2.42)” should be “(11.2.43)”.
- p. 423, 10th line from bottom: “Vahedi et al. (1994)” should be “Vahedi et al. (1993)”.
- p. 426, last line: “(11.5.6)” should be “(11.5.20)”.
- p. 431, line 8: “along” should be “along (in the plane of)”.
- p. 433, 1st line above Eq. (11.4.14): “ $(A_a/A_b)^{3/4}$ ” should be “ $(A_a/A_b)^{3/8}$ ”.
- p. 436, Eq. (11.5.5): “ $V_a(t)$ ” should be “ $-V_a(t)$ ”;
 Eq. (11.5.6): “ $V_b(t)$ ” should be “ $-V_b(t)$ ”.
- p. 439, line 2: “(10.2.8)” should be “(10.2.4)”.
- p. 440, Eq. (11.5.24): “0.327” should be “0.42”.
- p. 442, 3rd line below Eq. (11.6.3): “(11.5.14)” should be “ $V_s = -V(t)$ ”.
- p. 444, Eq. (11.6.12) (both occurrences): “ $\mathcal{E}(\omega t_0)$ ” should be “ $\mathcal{E}(\omega t_f)$ ”;
 1st line above Eq. (11.6.14): “ $x = s$ ” should be “ $x = 0$ ”.
- p. 450, 1st line after Eq. (11.7.7): “is the change” should be “is half the change”.
- p. 451, 5th line from the bottom: “ $V_{rf}^{1/2}$ ” should be “ V_{rf} ”.
- p. 455, Eq. (11.8.15): “ $+\frac{\pi}{2}$ ” should be “ $-\frac{\pi}{2}$ ”;
 Eq. (11.8.16): “ $\approx X_D I_1$ ” should be “ $\approx -X_D I_1$ ”;
 Eq. (11.8.17) should be: “ $\psi = -\tan^{-1} \frac{R_D}{X_D} \approx -\frac{R_D}{X_D}$ ”;
 1st line above Eq. (11.8.20): “ R_T ” should be “ $2R_T$ ”;
 Eq. (11.8.20): “ $\frac{1}{2}$ ” should be “ $\frac{1}{8}$ ”;
 1st line below Eq. (11.8.20): “(11.8.20)” should be “(11.8.20), using (11.8.16),”;
 Eq. (11.8.21): multiply the right hand side by “ -2 ”.

Chapter 12:

- p. 463, 2nd line: “Section 5.6” should be “Section 5.5”.
- p. 465, 2nd line above Eq. (12.1.8): “(18.5.2)” should be “(18.5.12)”.
- p. 466, 3rd line after Eq. (12.1.12): “we integrate” should be “we must consider the exponential decay within the skin layer of the plasma part of E_θ , which gives an average $E_\theta/2$. We integrate”
 4th line after Eq. (12.1.12): “the electric field E_θ ” should be “this”; “ 2π ” should be “ π ”.
- p. 467, Fig. 12.2: “ Z ” should be “ Z_s ”.

- p. 468, Example: “ $R_s \approx 25$ ” should be “ $R_s \approx 12.3$ ”.
- p. 472, 1st line after Eq. (12.2.6): “cubic” should be “quartic”;
 3rd line of last paragraph: “(12.2.6)” should be “(12.2.5)”;
 8th line of last paragraph: “(12.1.24)” should be “(12.2.5)”.
- p. 475, 2nd line above Fig. 12.6: “(10.4.24)” should be “(10.4.7b)”.
- p. 476, 3rd line in 2nd paragraph: “(3.3.7)” should be “from the equation preceding (3.3.7)”.
- p. 482, 2nd line of 2nd paragraph: “Section 5.4” should be “Section 5.5”.
- p. 484, 4th line from bottom: “ $f = 25$ MHz” should be “ $f = 5$ MHz”;
 3rd line from bottom: “ $l = 30$ cm ($k_z = 5.2$ m⁻¹)” should be
 “ $l = \lambda/4 = 30$ cm ($k_z = 5.2$ m⁻¹) and $\Psi = 0.02$ rad”.
- p. 485, 1st line after Eq. (12.4.3): “0.1 rad” should be “0.02 rad”;
 2nd line above Eq. (12.4.4): “ $m\pi/4$ ” should be “ $m\pi/2$ ”.
- p. 487, 3rd line: “Section 15.3” should be “Section 15.4”.
- p. 488, Problem 12.2: “ $\frac{1}{2}$ ” should be “ $\frac{1}{2}\text{Re}$ ”.

Chapter 13:

- p. 504, 2nd line of 1st complete paragraph: “(10.2.3) and (10.2.4)” should be
 “(10.2.1) and (10.2.2)”.
- p. 505, line 11: “(10.2.7)” should be “(10.2.12)”.
- p. 506, line 27: “Problem 4.12” should be “Problem 4.14”.
- p. 510, 4th line of 2nd paragraph: “ T_e ” should be “ u_B ”.
- p. 512, line 3: “(10.2.9)” should be “(10.2.4)”.
- p. 513, 3rd line above Eq. (13.2.1): “Problem 4.12” should be “Problem 4.14”.
- p. 514, 2nd line of 2nd paragraph: “Section 11.6” should be “Section 11.8”.
- p. 515, Eq. (13.2.5): “ k_z ” should be “ $k_z k_\perp R$ ”.
- p. 521, 3rd line of *Example*: “Section 5.4” should be “Section 5.5”;
 5th line of *Example*: “(10.2.8)” should be “(10.2.13)”;
 7th line of *Example*: “(10.2.1)” should be “(10.2.9)”;
 8th line of *Example*: “(10.2.15)” should be “(10.2.11)”, and “(10.2.14)” should be “(10.2.15)”.
- pp. 523–24: “ K_\perp , K_\times , K_r , K_l , and K_\parallel ” should be “ κ_\perp , κ_\times , κ_r , κ_l , and κ_\parallel ” wherever they
 appear in the text and equations.
- p. 524, Eq. (13.2.25): the right hand side should be “ $\frac{\omega_{ce}}{\omega}$ ”.
- p. 528, 2nd line above Eq. (13.3.5): “(2.2.1)” should be “(2.2.2)”.
- p. 529, Figure 13.22: “ ${}_z c/\omega_{pe}$ ” should be “ ${}_z k_z c/\omega_{pe}$ ”.

Chapter 14:

- p. 553, Eq. (14.4.2): multiply the right hand side by “ $-\frac{1}{D_a}$ ”.
- p. 554, 3rd line above Eq. (14.4.10): “(5.1.5)” should be “(5.1.6)”.
- p. 555, line 6: “(14.4.5)” should be “(14.4.4)”.
- p. 557, 1st line of 2nd paragraph: “(14.4.10)” should be “(14.4.13)”;
- Eq. (14.4.24) (two occurrences): “ R ” should be “ $2R$ ”.
- p. 559, last line: “ $\lesssim l$ ” should be “ $\gtrsim l$ ”.
- p. 564, 8th and 10th line from bottom: “target” should be “substrate”.
- p. 565, line just above Eq. (14.6.2): “substrate” should be “target”.
- p. 566: Equation number “(4.6.10)” should be “(14.6.10)”.

Chapter 15:

- p. 572: “300 nm” in the equation should be “500 nm”.
- p. 575, 5th line below Eq. (15.1.13): delete “(dashed curve)”.
- p. 591, line 7: “(15.3.7)” should be “(15.3.6)”.
- p. 593, Table 15.2, reaction 4: “ CF_3^- ” should be “ CF_3^+ ”.
- p. 597, Eq. (15.3.13) and Eq. (15.3.14): “ n_{Si} ” should be “ $4n_{\text{Si}}$ ”.
- p. 598, 2nd line: “Table 15.1 and Table 15.2” should be “Table 15.2 and Table 15.3”.
- p. 603, line 7: “copper chloride (CuCl_3) is” should be “the copper chlorides are”.
- p. 611, 2nd line from the bottom: “Figure 15.17b” should be “Figure 15.15b”.
- p. 613, 6th line after Eq. (15.5.16): “spaces” should be “sidewalls”;
- 7th line after Eq. (15.5.16): “ $\tan \theta \approx (d - w)/2h$ ” should be “ $\tan \theta \approx 2h/(d - w)$ ”.

Chapter 16:

- p. 620, line 6: “crystalline, which” should be “crystalline; crystalline films”.
- p. 626, line above Eq. (16.2.10): “Initial steps in film” should be “Film”;
- Eq. (16.2.10) should be: “ $\text{SiH}_3(\text{g}) + \text{SiG}_3(\text{OH}) \rightarrow \text{SiGH}_2 + \text{SiO}_2 + \text{H}_2$ ”;
- add after Eq. (16.2.10): “where $\text{G} = \frac{1}{2}\text{O}$ is an oxygen atom that is shared with another surface silicon atom.”
- p. 629, 3rd line after Eq. (16.2.15): “(16.2.14)” should be “(16.2.13)”.
- pp. 630–33: The equations in Sec. 16.3 were not sequentially numbered; equation number (16.3.2) was inadvertently omitted.
- p. 642, Eq. (16.4.21): “ $(s - x)$ ” should be “ $(x - s)$ ”.
- p. 646, 2nd line above PROBLEMS: “Section 5.6” should be “Section 5.5”.

Chapter 17:

- p. 653, 1st line after Fig. 17.1: “(17.2.5)” should be “(17.2.7)”.
- p. 661, line 17: “ 10^{-3} ” should be “ 10^{-13} ”;

line 18: “ 10^{-5} ” should be “ 10^{-15} ”;

line 20: “ 10^{-4} ” should be “ 10^{-14} ”;

line 22: “ 10^{-3} ” should be “ 10^{-13} ”.

p. 664, last line of 2nd paragraph: “ $K_{\text{rec}}n_i$ ” should be “ $1/K_{\text{rec}}n_i$ ”;

1st line below the unnumbered equation: “Problem 3.12” should be “Problem 3.15”.

p. 673, 14th line below Section 17.6: “(17.3.2)” should be “(17.3.12)”.

p. 674, line 6: “Figure 11.23” should be “Figure 11.28”;

line 24: “Section 10.5” should be “Section 10.6”.

Chapter 18:

p. 680, line 10: “Kortshagen et al. (1997)” should be “Aliev et al. (1997)”.

p. 689, 1st line after Eq. (18.2.1): “ $\bar{\mathbf{E}}_a + \mathbf{E}_h$ ” should be “ $\bar{\mathbf{E}} = \bar{\mathbf{E}}_a + \bar{\mathbf{E}}_h$ ”;

Eq. (18.2.3): “Re” should be “ $\frac{1}{2}\text{Re}$ ”;

last line: “due the the” should be “due to the”.

p. 690, line 4: “that” should be “than”.

p. 691, 1st line after Eq. (18.2.13): “ cm^2 ” should be “ m^2 ”.

p. 694, last line of 1st paragraph: “Sections 18.4 and 18.5” should be “Sections 18.5 and 18.6”.

p. 700, line 15: “localized rf” should be “localized time-varying”.

p. 701, Eq. (18.4.10): “ f_{ek} ” should be “ \tilde{f}_{ek} ”.

p. 702, Eq. (18.4.11): “ $\tilde{A}_2(\mathbf{r})$ ” should be “ $\tilde{A}_2^*(\mathbf{r})$ ”;

Eq. (18.4.13): “ $-\frac{e^2\pi}{m^2}$ ” should be “ $\frac{e^2\pi}{m^2}$ ”;

Eq. (18.4.14): “ $-\pi$ ” should be “ π ”

Eq. (18.4.17): “ $(1 - \mathbf{k} \cdot \mathbf{v})/\omega$ ” should be “ $(1 - \mathbf{k} \cdot \mathbf{v}/\omega)$ ”.

p. 703, 3rd line above Stochastic Heating section: “ P_y ” should be “the Hamiltonian H ”.

p. 705, Eq. (18.4.34): “ ν ” should be “ v ”.

p. 709, 1st line after Eq. (18.5.12): “collisionless” should be “collisional”.

p. 710, 1st line after Eq. (18.5.20): “2” should be “ $2D_0$ ”;

Eq. (18.5.23) and last line: “ I_0 ” should be “ K_0 ”.

p. 711, Eq. (18.5.25): “ I_0 ” should be “ K_0 ”.

p. 711, last line and 1st line on p. 712: “generalized Bohm criterion (6.4.1) can be written as” should be “Bohm criterion for the ion velocity u_B entering the sheath can be written as (Amemiya, 1997)”.

p. 712, 4th line after Eq. (18.6.3): “Finally,” should be “Approximating the electron wall flux as $\frac{1}{4}\bar{v}_e n_e(\text{wall})$, and”;

7th line after Eq. (18.6.4): “versus” should be “various”;

- 5th line of the last paragraph: delete the words “and axial”.
- p. 714, Eq. (18.6.6): “ $\frac{d}{d\mathcal{E}_T}$ ” should be “ $-\frac{d}{d\mathcal{E}_T}$ ”;
- 3rd line after Eq. (18.6.6): “(18.3.26)” should be “(18.6.5)”.
- p. 718, line 1: “the figure”, should be “Fig. 11.6”;
- 2nd term of Eq. (18.6.12): “ $(\frac{m}{2e})^{1/2}$ ” should be “ $\frac{2}{3}(\frac{m}{2e})^{1/2}$ ”;
- line 1 of the last paragraph: “(18.6.8)” should be “(18.6.12)”.
- p. 719, line 4: “(18.6.8)” should be “(18.6.12)”;
- line 8: “ Φ_0 ” should be “ $\mathcal{E} = \Phi_0 \approx 3 \text{ V}$ ”.

Appendices:

- p. 734, Eq. (C18): The last “+” sign should be an “=” sign.

References and Index:

- p. 735, after Allis reference: add “Amemiya, H. (1997) *J. Phys. Soc. Jpn.* **66**, 1335.”.
- p. 740, line 25: “152” should be “147”;
- line 27: “147” should be “152”.
- p. 745, 14th line from the bottom: “Selwin” should be “Selwyn”.
- p. 747, line 17: “T.D. Rognlien (1994)” should be “T.D. Rognlien (1993)”.
- p. 751, 2nd line from the last: “Thompson ionization” should be “Thomson ionization”.

Acknowledgement:

Special thanks to Dr. Jie Qiu and Prof. Yi-Kang Pu at Tsinghua University, Beijing, for finding many of these errors.