**Errata in *The Essence of Materials for Engineers***

Preface:

* Page xiii, 1st para., line 6: Correct to read: “ … the science courses they are taking underlie …”
* Page xiii, 1st para., line 7: Correct to read: “ … basic engineering courses they are taking underlie …”

Chapter 1:

* Page 7, 4th para., line 8: Correct to read: “ … are produced as commodity materials …”
* Page 7, 5th para., line 5: Correct to read: “ … require new materials as well .”
* Page 10, Figure 1.2 caption, line 2: Correct to read: “ … are shown as shaded areas.”
* Page 15, 2nd para., line 5: Amend to read: “ … of World War II (1945), at which times the use of metals grew dramatically.”
* Page 16, Figure 1.5 caption: Amend last sentence to read:

“Compare materials lie on the same dashed design guideline positioned to pass through a material known to have been used successfully in the same or similar application before and drawn parallel to the appropriate derived relationship between f and .”

* Page 18, Problem 1.1-1: Amend to read: “From familiarity with inherently soft …”
* Page 18, line 2: Amend to read: “ … a low-melting eutectic of iron and carbon, known a “cast iron”, from which …”

Chapter 2:

* Page 22, top, line 1: Update to read: “ … on which nearly 7 billion of us live …”
* Page 23, Table 2.1, 2nd line under Nayaya and Vaisheshika: Amend to read: “ … then in trios of pairs to create sextets.”
* Page 27, top, line 4: Amend to read: “ ... and physics, the Pauli exclusion principle, by which, no two …”
* Page 30, line1: Amend to read: “ … has an atomic weight that is the average of the two other …”
* Page 35, 3rd para. Under section 2.5, line 1: Amend to read: “ … shows an electropositive element (here, Li) and an electronegative element (here, F) whose atoms have formed positive and negative ions (here, Li+1 and F-1, respectively.”
* Page 38, top, lines 7: Amend to read: “ … create a network in the solid aggregate or exist only within the molecules that comprise an aggregate when the material is in its solid state.”
* Page 38, 2nd para., line 5: Correct to read “ … can be seen in Figure 2.6c … “
* Page 39, Table 2.6: Add a note beneath the table: “Note: 1 kJmole = 1.04x10-2 eV/atom.”
* Page 40, under **Van der Waals bonding,** lines 5-6: Correct to read: “ ... (2) permanent dipole bonding, and (3) polar molecule-induced dipole bonding.”
* Page 41, top, line 3: Correct to read: “Returning to Figure 2.5, here is … “
* Page 42, Eqn. 2.1: Correct to read: U = -∫ Fdx

Chapter 3:

* Page 48, top, lines 7-8: Correct to read: “ … do not change their basic chemical formula, as H2O … “
* Page 50, top, line 2: Amend to read: “ … this position xo, which means …”
* Page 50,, 2nd para., , line 4: Amend to read: “ … that increases from xo with increasing …”
* Page 51, Figure 3.3: Correct x1 on “Separation” axis to xo and in the caption, line 7, correct to read “ … interatomic spacing xo at absolute zero …”
* Page 51, also on Figure 3.3: Add another vertical long-dash/dot/long-dash line at the point where the **bold** curve crosses the horizontal dashed line at E1/T1>0 K.
* Page 53, Figure 3.5: Correct to reverse G with H and C with D.
* Page 57, top, line 4: Correct to read: “ … well above room temperature, but well below melting …”
* Page 58, 3rd para., line 4: Amend to bold-font “ … **allotropic transformation** … “
* Page 61, Figure 3.8, caption lines 1-2: Amend to read “ … light circles represent anions, while dark-shaded circles represent cations.”
* Page 61, top, lines 1-2 under item 2: Correct to read: “ … into whatever fraction of intersticies …”
* Page 62, Figure 3.9e: Correct legend beneath the unit cell so that the most lightly shaded circle is +2 and the intermediate-shaded circle is -2. Correct
* Page 64, 2nd new para., line 3: Correct to read: 6.022x1023
* Page 64, last para., line 5: Amend to read: “ … as well as generally heavier metallic elements …”
* Page 66, under **Crystalline Carbon,** line 1: Amend to read: “ … as it is a Group IV element. [delete -]
* Page 66, last line: Amend to **bold-font**: “ … is appropriately called **diamond cubic (DC)** crystal structure …”
* Page 68, 1st new para.,, line 3: Amend to **bold-font**: “ … referred to as **carbon nanotubes**, as the … “
* Page 68, under **High-performance Ceramics,** line 4: Amend to read “ … SiO2 is 49% … “
* Page 68, under same heading, line 7: Correct to read “ … with a high degree of …”
* Page 69, under Polymer Macromolecules, line 6: **Bold-font:**  “ … known as a **mer,** while …”
* Page 72, under section 3.6, line 1: Amend to italicize: “All of you are familiar with *plastics* … “
* Page 74, under **Determining Points in a Lattice,** item 2, lines 2-3: Correct to read: “ … in the order a (x or h perpendicular to the page or paper), b (y or k horizontal on the page or paper), and …”
* Page 79, Figure 3.14: Correct label on space between planes A-A” and B-B” to read dhkl

Chapter 4:

* Page 90, 4th new para., line 5: Amend to read: “ … zero-dimensional (0D), one-dimensional (1D), … “
* Page 92, top, line 2: Amend to read: “ … occur as nutrients for …”
* Page 93, Figure 4.2: Revise “self-interstitial” portion of figure by adding another (extra) circle, the same size and shading as the others, forced between the usual pattern of 4 touching 1 in a square.
* Figure 94, Eqn. 4.3: Amend the units shown to read: “vacancy/atom” and, beneath, “vacancies/mole of atoms”
* Page 94, in Illustrative Example 4-1: Proper arrange the expression following “Thus” to read

(3.3x1028 atoms/m3) exp (-0.55 eV/atom)/(8.62x10-5 eVatom-K)(599K)

* Page 97, Figure 4.4: The figure would be more clear – and meaningful --- if the blue-shaded area within arrows encompassed rows with 7 atoms above rows with 6 atoms [versus 6 over 5) so that the extra half-plane was centered – and indicated by the symbol for the dislocation (i.e., an upside-down T)
* Page 98, Figure 4.5: Revise here as in Figure 4.4, above.
* Page 98, under **Screw dislocation,** line 3: Amend to read: “ … of the crystal in Figure 4.5 about two-thirds of the way back” and, in line 3 of the caption, “ … on the right face, about two-thirds of the way back.”
* Page 102, Figure 4.8: Correct figure to properly show the small-angle grain boundary as the angle between a line extended from the lower line [beneath the dashed line] and the line shown to the left of the extended line
* Page 107, Problem 4.4-1: Add at the end “You might even find an animation of an edge dislocation moving through a crystal.”

Chapter 5:

* Page 111, line 4: Amend punctuation to read: “ … to be amorphous, is to plot …”
* Page 113, top, after line 3: Add “Launching the Space Shuttle Challenger from the Kennedy Space Center in Florida on the unusually cold (-1°C/31°F) morning of January 26, 1986 led to catastrophic disintegration of the vehicle at 11:38 EST, 73 seconds into its flight. The cause was traced back to a large O-ring seal located in the right solid rocket booster (SRB) to not seat properly, as it was stiff from operating well below its Tg of 12°C/53°F. Once pressurized hot gas from inside the solid rocket motor breached the seal and impinged on adjacent hardware attaching the adjacent SRB , causing it to lose its strength and fail, aerodynamic forces torn the entire vehicle apart.”
* Page 115, under section 5.3, line 6: Amend to bold-font: “ … or **macromolecules** …”
* Page 117, last two lines: Amend to read: “ … using ethylene as the …”
* Page 120, Figure 5.6, should be redrawn in a NEW EDITION using a sketch to be provided by the author.
* Page 120, 4th para., line 3: Amend to read: “ … are shown in Figure 5.7 … “
* Page 121, Figure 5.7 should be redrawn in a NEW EDITION using a sketch to be provided by the author.
* Page 122, Figure 5.8 could be deleted in a NEW EDITION, as it duplicates information presented better in Table 5.2.
* Page 122, under **Linear polymers**, last line: Amend to read: “Figure 5.9a shows a linear …”
* Page 125, 1st line at top: Amend to read: “A cross-linked polymer is …”
* Page 127, Figure 5.11: Correct the letter-format molecular formula by deleting the Hs and bond at each end – of each formula – and make the bond between Cs double (=).
* Page 129, in a NEW EDITION, make the dark-shaded circles in part d the same size as the light-shaded circles.
* Page 131, under section 5.8, line 1: Amend the sentence to read: “ … in the context of liquid crystal display (LCD) flat screen … )
* Page 133, Summary, 1st line: Amend to read: “There are materials that are very complex because …”

Chapter 6:

* Page 140, 1st new para., line 1: Amend to read: “ … are the material’s response …”
* In a NEW EDITION, a new Chapter would added, right after Chapter 6, entitled “Nanoscience, Nanostructure, and Nanomaterals”.
* Page 152, Figure 6.3, caption line 1: Amend to read: “Plot of two correlating properties using …”
* Page 155, top, line 1: Amend to read: “ … structures were “dumb”.”
* Page 155, top, line 6: Amend to read: “ … of the airplane’s flight …”
* Page 155, 3rd para., line 6: Amend to read: “Just like a plant can adjust its leaves or flowers to …”
* Page 155, 3rd para., line 8: Amend to read: “ … of welder darken almost … “

Chapter 7:

* Page 166, 3rd para., line 2: Amend to read: “ … is the tank used to contain liquid propane …”
* Page 168, top, line 3: Amend to read: “ … is not a law of physics that …”
* Page 168, under **Engineering stress,** line 3: Amend to read: “ … are megapascals …”
* Page 170, top, last two lines in para.: Amend to read: “ does not indicate …”
* Page 171, 3rd para., line 1: line 1: Amend to read: “When loading is applied in more than one direction, that is, is biaxial or triaxial…”
* Page 171, 4th para., line 7: Bold-font: “ … what is called a **neck** or **necking** …
* Page 173, 3rd new para., last line: “Amend to read: “ shown beneath the strain axis of Figure 7.3, the difference between Point and Point 1 (i.e., Point 3) and Point , respectively.”
* Page 178, Figure 7.10: Redraw left figure to have a real barrel shape, as in the top of Figure 7.11, but with dashed starting cylindrical shape as well.
* Page 179, Figure 7.11: Make fractured cylinder in b a right cylinder, with same-size upper and lower portions.
* Page 180, top, line 4: Correct to read: “ … because strong materials …”
* Page 183, top, line 2: Amend to read: “The tests uses the …”
* Page 191, top, line 1: Amend to read: “ … exhibits no endurance limit.”
* Page 191, top, right after line 4: Add: “Common practice is to refer to the upper allowable value of stress that will allow a certain life (i.e., number of cycles before failure) as the *fatigue limit*.”
* Page 192, top, line 1: Amend to read: “ … like ripples formed in the sand on a beach demarcate a receding tide.”
* Page 195, 1st new para., line 1: “Amend to read: “ … above about 0.4 Tm …
* Page 199, Summary, 2dn para.: Rewrite entirely as: “Strong, inherently brittle materials, like ceramics, tend to exhibit an engineering stress-engineering strain diagram with an extensive linear elastic region, while ductile metals tend to exhibit reasonable linear elastic regions. Many polymers, especially elastomers, do not exhibit much, if any, linearity, even though they behave elastically. The linear region of the elastic portion of a stress-strain curve is defined by Hooke’s law, with a slope that …”
* Page 203, Problem 7.6-1, line 2: Correct to read: “ … for each here, plot their …”

Chapter 8:

* Page 207, Objective 2a, line 2: Amend to read: “ … on close-packed planes and … “
* Page 218, Figure 8.8: Add a new line, with a slope the same as the line shown, but to the right, passing from 0.002 offset strain (labeled “).002”) on the strain axis, and intersection the curved portion of the existing curve to result in the value of YS shown.
* In a NEW EDITION, Figure 8.9 on page 219, should be redrawn per sketch to be provided by the author.
* Page 228, Figure 8.16: Change the “C” at the left (by the notch) to “a”, change the equation shown at that location to

 = 2o (a/t)1/2

and change “2c” (at the elliptical notch) to “2a”

* Page 228, correct Eqn. 8.5 to read:

Kt = max/o = 2(a/t)/1/2

* Page 228, correct Eqn. 8.6 to read:

c = [2Es/a]1/2

* Page 231, Table 8.3: Correct units under KIc to: “MPa√m”
* Page 232, under section 8.8, 2nd para., line 2: Amend to read “ … consider how complex the Burgers vector for a dislocation in an ionic or covalent bonded crystal would be.”
* Page 240, Problem 8.7-2, line 1: “ … on the Internet to …”

Chapter 9:

* Page 243, under section 9.3, line 1: Amend to read: “ … than for mechanical properties …”
* Page 244, top, line 7: Amend to read: “ … is receiving favor over …”
* Page 246, under section 9.3, line 6: Correct to read: “ … which is 1.6x1019 coulombs per second …”
* Page 246, 2nd to last line on page: Amend to read: “ … is a fundamental electrical property of a material.”
* Page 247, top, line 8: Amend to read: “ … in descending order …”
* Page 247, last para. on page, lines 4-5: Amend to read: “Third, the next higher available … “
* Page 249, Figure 9.4: Correct as follows: (1) Eliminate all solid and open circles; (2) add “VB” label to all lower bands [like that on the leftmost figure] and “CB” to the all upper bands [like that on the leftmost figure]; in part c, add “Eg” next to the short arrow [as for leftmost figure].
* Page 249, Figure 9.4, caption, line 2 and, then, line 3: Amend to read: “ … in a partially filled valence band (shown by shading) into “ and, then, “ … in a partially filled valence band (shown by shading) …”
* Page 249, top, line 3: Amend to read: “ … in a partially filled valence band (with the level to which energy states are filled always indicated by shading).”
* Page 249, last para., line 6: Add new sentence: “ … or so is required. The energy needed to jump across the forbidden zone or band gap is the **band gap energy** Eg.”
* Page 252, under section 9.5, line 2: Amend to read: “ … metalloids, or semiconductors, occasionally … “
* Page 252, Figure 9.6: Add labels to the plot, as follows: “VB” left of zero on the horizontal axis and “CB” to the right.
* Page 253, 1st new para., lines 5-6: Amend to read: “ … move: the hole toward the – side of the field and the free electron toward the + side of the field.”
* Page 253, Eqn. 9.10: Correct the right-most equation to read:

“ = ni|e|(e+h) ” [no underlines!}

* Page 254, Figure 9.8: Correct by: (1) Eliminating solid (blue) circle on the lower long dash above the VB box of the center figure for “n-type” and (2) also remove the N in a large circle with its arrow. Also, for the right-hand figure for the “p-type”, add a large circle [as originally with “N”] with “h” with an arrow pointing to the left-hand blue circle on the topmost level of the VB.
* Page 255, Figure 9.9: Add labels with arrows pointing to the large center atom in the center and right-hand array, as follows, respectively: “n-type dopant” and “p-type dopant”
* Page 256, Figure 9.11: Correct label in (a) to read: “Exhaustion region”
* Page 258, Illustrative Example 5.1, 2nd line in **bold** title: Eliminate the bold font for “Calculate the electrical …”
* Page 267, last line before section 9.10: Add a new sentence: “Many ceramics with a perovskite crystal structure exhibit piezoelectric behavior.”

Chapter 10:

* Page 275, Objective 2: Amend to read: “ … and general behavior of the …”
* Page 284, top, line 1: Amend to read: “ … speed of sound in the solid material.”
* Page 286, Figure 10.3: Add to labels on both plots, left and right: To the right of each, at each level, change to “@0 K”, “@T1”, “@T2”, “@T3”; and, for each plot, at their left, correspondingly add “E1” [for T1], “E2” [for T2], and “E3” [for T3]
* Page 287, 2nd new para., line 1: Amend to read: “Low-expansion alloys of iron and …”
* Page 287, at end of 2nd new para.: Add new sentence: “Refer back to section 6.6 to see how CTE correlates to TMP of materials, as exemplified by values for generally high-melting ceramics versus generally less high melting metals.”

Chapter 11:

* Page 301, under section 11.2, line 2: Add: “ … or robustness, and, in turn, safety.”
* Page 303, Figure 11.1: Correct: Add missing arrows point outward from each face of the square at the right, just below the horizontal line [like all others]
* Page 312, under Precipitation Hardening, lines 3-4: Amend to read: “ … a dissolved nonmetallic solute (e.g., C or Si) to form a ceramic compound (e.g., carbide or silicide) or much more frequently …”
* Page 313, same para. as above: Amend to read: “ … more frequently, metallic solute (e.g., Al and/or Ti in Ni) to form an intermetallic compound (e.g., Nix(Al,Ti)y).”
* Page 313, same para., following the line above: Add the sentence: “Whether a nonmetallic/ceramic or an intermetallic compound, the precipitate is always an ordered phase (in which specific atomic species are located on specific, versus random, lattice points) that provides tremendous resistance to shear, and, so is a very effective strengthener. The second phase forms …”
* Page 314, 3rd para. on page: “The newly formed  phase strengthens or hardens the alloy because, as an ordered AxBy compound, it is …”
* Page 315, top, line 6: Amend to read: “ … leads to pre-stages of the final …”
* Page 318, top, line 3: Amend to read: “ The so-called “ice-box” rivets then …”
* Page 321, top, line 7: Correct to read: “Nitinol has been …” [no underline!]
* Page 324, 2nd para., line 3: Amend to read: “ … a hard ordered-compound second phase …”
* Page 326, Problem 11.3-2c: Change to read: “Concrete with added polymer dispersoids” [no underline!]

Chapter 12:

* Page 332, 2nd para., item 5, line 2: Correct to read: “ … beyond single-phase, solid-solution ….”
* Page 332, 3rd para., lines 2-3: Amend to read: e” … or interstitially, and what happens when the limit of solubility at any temperature is exceeded can have different, but profound, effects on properties.”
* Page 334, top, line 2: Amend to read: “ … scale that they may not have distinguished …”
* Page 334, FN2, line 2: Amend to read: “ … with an optical microscope …”
* Page 336, 1st bullet near bottom, lines 2-3: Amend to read: “ … the line continues to higher pressure because …”
* Page 337, 1st bullet at top, line 2: Amend to read: “ … by definition) represented by M [in square box].”
* Page 337, 3rd bullet, line 2: Amend to read “ … by definition, designated by B [in a square box]”
* Page 338, EQN. 12.2: Correct to read: “Hmelting” [vs. Hvapor] [no underline!]
* Page 338, text just beneath Eqn. 12.2: Amend to read: “ … 1 and 2; Hmelting is the latent heat of melting for the metal; and …” [no unxderline!]
* Page 339, Illustrative Problem 12.1, point b, line 5: Amend to read: “Go to any temperature between the critical point (but above 0°C) and …”
* Page 340, Figure 12.2: REPLACE with proper phase diagram for water to high pressures … specifically the one available for free use under Common Creative Attributes Share-Alike 3.0 on Wikimedia; Google “Phase diagram”, and check image under “Crystal Phase Diagrams”.
* Page 342, 1st bullet, line 2: Correct to read: “ … MP at 1084.87°C (on this diagram), above which …”
* Page 342, 2nd bullet, line 2: Amend to read: “ … MP of approximately 1455°C (on this diagram).” AND, correct on Figure 12.3, right-hand axis [versus erroneous 1465°C]
* Page 342, Figure 12.3: Add inset to show region around the vertical dashed line at 30 wt.% (i.e., Co) per jpeg scan labeled “Inset for Fig. 12.3” attached to the email transmitting this document
* Page 343, 4th bullet on page: Amend to read: “In the narrow region between …”
* Page 343, 5th bullet, line 2: Correct to read: “ … (i.e., between the liquidus and the solidus lines at T1 and T2, respectively) two ….” [no underlines!]
* Page 343, 6th bullet, line 2: Amend to read: “ …, say T2, are given …)
* Page 343, last bullet on page, last line: Correct to read: “ … here around 354.6°C.”
* Page 344, 1st bullet, line 1: Amend to read: “ … crystals of S (dark blue in the figure) begin to form …”
* Page 347, 1st new para. on page, below bullets, line 2: Amend to read: “ … shown in Figure 12.4 b by …”
* Page 349, Table 12.2: Correct to highlight “Eutectic”, “Eutectoid”, “Peritiectic”, and “Congruent melting compound” using either an ellikpse and shading within or **bold font**.
* Page 350, Eqn. 12.4: Correct to read: “S1 ⇔ S2 + S3”
* Page 352, Figure 12.8: Correct all labels, as follows, left to right, top to bottom:

Ni5Zr

Ni7Zr2

Ni3Zr

Ni8Zr3

Ni5Zr4

Ni10Zr7

NiZr

NiZr2 .... two places, one near far right

Also, “Ni55Zr” and delete “SGUP”

Chapter 13:

* Page 367, Eqn. 13.2, 2nd form: Correct to read:

or 4 Gvr2 + 8r = 0

* Page 368, 2nd bullet, lines 4-6: Amend to read “ … so greater super cooling between the equilibrium transformation temperature rapidly increases the exponential term so that the magnitude of n\* increases as shown …”
* Page 369, top, line 1: Amend to read: “The equation shows that the rate of nucleation is maximum at an intermediate degree of supercooling, as too little supercooling produces fewer nuclei to which atoms attach rapidly but only to result in a low net rate of nucleation, while too much supercooling causes very slow atom attachment to the very large number of forming nuclei to result in an overall low rate of nucleation.”
* Page 385, Figure 13.15: Correct to have vertical dashed lines at CS1 and CS2 begin where the horizontal lines at T1 and T2, respectively, intersect the solid curved lines on the phase diagram.
* Page 387, 2nd para., 2nd bullet, line 2: Amend to read: “ … the two-phase L+S region between the liquidus and the solidus temperature for alloy CA (or S2 for alloy CE), appearing …”
* Page 390, Illustrative Example 13.2: Correct numerical calculation lines as follows [no underlines!]:

% = (98-40)/(98-5) x100 = 62.4%

%  = (40-5)/(98-5) x100 = 37.6%

% eutectic = (40-18.3)/(61.9-18.3) x100 = 49.8%’

% pro-eutectic  = (61.9-40)/(61.9-18.3) x100 = 50.2%

%  in eutectic = (98-61.9)/(98-5) x100 = 38.8%

%  in eutectic = (61.9-5)/(98-5) x100 = 61.2%

* Page 398, under Isothermal Transformation Diagram, Eqn. 13.22: Correct to read: “ … ⇔  (0.022 wt.% C)”

Chapter 14:

* Page 425, under section 14.6, line 1: Correct to read:: “ … ways to toughen inherently brittle …”

Chapter 15:

* Page 434, I a NEW EDITION, revise Table 15.1 to add common matrix materials for each reinforcement.
* Page 434, Table 15.1, page 436, Table 15.2, and page 451-452, Table 15.5: Correct heading in column to read: “Modulus of Elasticity” versus erroneous “Electric modulus”
* Page 442, Eqn. 15.10: Correct to read:

ct/Ect = m/Em (Vm) + f/Ef (Vf)

… [without parentheses and no underlines]

Chapter 16:

* Page 462, top, 2nd para., line 2: Correct to read: “ … is the principal element …”
* Page 464, Eqn. 16.7: Correct by deleting “\_\_” beneath the “+” in reaction to read:

2H+ + 2e- ⇒ H2(gas)

* Page 467, Table 16.1: Correct entries, as follows:

Cu3+ + 2e- ⇒ Cu to Cu2+ + 2e- ⇒ Cu

Pb3+ + 2e- ⇒ Pb to Pb2+ + 2e- ⇒ Pb [no underline]

Ni3+ +2e- ⇒ Ni to Ni3+ +2e- ⇒ Ni

* Page 469, in Illustrative Example 16.1: Correct equations to read, no underlines:

V = (VCuo – VPbo) – RT/2nF ln [MPb2+]/[MCu2+]

ln [xM]/[0.6M]

 ln [xM]/0.6M] = -0.041 v/0.013 v

Chapter 17:

* NO ERRATA!