Appendix C Costs and Relative Costs for Selected Engineering Materials

his appendix contains price information for the same set of materials for which the properties are included in Appendix B. The collection of valid cost data for materials is an extremely difficult task, which explains the dearth of materials pricing information in the literature. One reason for this is that there are three pricing tiers: manufacturer, distributor, and retail. Under most circumstances, we have cited distributor prices. For some materials (e.g., specialized ceramics such as silicon carbide and silicon nitride), it was necessary to use manufacturers' prices. In addition, there may be significant variation in the cost for a specific material. There are several reasons for this. First, each vendor has its own pricing scheme. Furthermore, cost will depend on quantity of material purchased and, in addition, how it was processed or treated. We have endeavored to collect data for relatively large orders—that is, quantities on the order of 900 kg (2000 lb_m) for materials that are ordinarily sold in bulk lots—and also for common shapes/treatments. When possible, we obtained price quotes from at least three distributors/manufacturers.

This pricing information was collected in January 2007. Cost data are in U.S. dollars per kilogram; in addition, these data are expressed as both price ranges and single-price values. The absence of a price range (i.e., when a single value is cited) means either that the variation is small or that, on the basis of limited data, it is not possible to identify a range of prices. Furthermore, inasmuch as material prices change over time, it was decided to use a relative cost index; this index represents the per unit mass cost (or average per unit mass cost) of a material divided by the average per unit mass cost of a common engineering material—A36 plain carbon steel. Although the price of a specific material will vary over time, the price ratio between that material and another will, most likely, change more slowly.

Material/Condition	Cost (\$US/kg)	Relative Cost		
PLAIN CARBON AND LOW-ALLOY STEELS				
Steel alloy A36				
 Plate, hot rolled 	0.90-1.50	1.00		
 Angle bar, hot rolled 	1.00-1.65	1.0		
Steel alloy 1020				
 Plate, hot rolled 	0.90-1.65	1.0		
 Plate, cold rolled 	0.85-1.40	0.9		
Steel alloy 1040				
 Plate, hot rolled 	0.90-0.95	0.7		
 Plate, cold rolled 	2.20	1.7		

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Material/Condition	Cost (\$US/kg)	Relative Cost
Steel alloy 4140		
• Bar, normalized	1.50–2.60	1.6
• H grade (round), normalized Steel alloy 4340	5.00	3.9
Bar, annealed	2.55	2.0
• Bar, normalized	3.60	2.8
STAINL	ESS STEELS	
Stainless alloy 304	6.20-9.20	6.0
Stainless alloy 316	6.20-11.70	7.3
Stainless alloy 17-7PH	9.20	7.1
CAS	T IRONS	
Gray irons (all grades)	1.75–2.40	1.7
Ductile irons (all grades)	2.00–3.20	2.0
ALUMIN	IUM ALLOYS	
Aluminum (unalloyed)	2.65–2.75	2.1
Alloy 1100 • Sheet, annealed	5.30-5.50	4.2
Alloy 2024	3.30–3.30	4.2
• Sheet, T3 temper	12.50-19.50	12.9
• Bar, T351 temper	11.00–21.00	13.4
Alloy 5052		
• Sheet, H32 temper	4.85–5.10	3.9
Alloy 6061	6.60.0.50	
Sheet, T6 temperBar, T651 temper	6.60–8.50 5.10–7.50	5.7 5.0
Alloy 7075	3.10-7.30	5.0
• Sheet, T6 temper	11.30–14.70	10.0
Alloy 356.0		
 As cast, high production 	2.70–3.35	2.4
 As cast, custom pieces 	17.50	13.6
• T6 temper, custom pieces	18.90	14.7
СОРРЕ	ER ALLOYS	
Copper (unalloyed)	5.60-7.00	4.8
Alloy C11000 (electrolytic tough pitch), sheet	7.60–11.60	7.4
Alloy C17200 (beryllium-copper), sheet	9.00–36.00	17.5
Alloy C26000 (cartridge brass), sheet	7.10–12.80	7.5
Alloy C36000 (free-cutting brass), sheet, rod	7.20–10.90	7.0
Allow C71500 (copper–nickel, 30%), sheet	27.00	21.0
Alloy C93200 (bearing bronze) • Bar	9.70	7.5
• As cast, custom piece	23.00	17.9
•	IUM ALLOYS	
Magnesium (unalloyed)	3.00–3.30	2.4
Alloy AZ31B	2.22	 .
• Sheet (rolled)	17.60–46.00	23.4
• Extruded	9.90–14.30	9.4
Alloy AZ91D (as cast)	3.40	2.6

THTANIUM ALLOYS Commercially pure	Relative Cos	Cost (\$US/kg)	Material/Condition
 ASTM grade 1, annealed ASTM grade 2, annealed Mono-120,000 Alloy Ti-5Al-2.SSn Alloy Ti-6Al-4V 66.00-154.00 PRECIOUS METALS Gold, bullion PRECIOUS METALS Gold, bullion PRECIOUS METALS Gold, bullion PRECIOUS METALS Molybdenum, commercial purity Tantalum, commercial purity Tantalum, commercial purity Tantalum, commercial purity Tungsten, commercial purity Nickel, commercial purity Nickel, commercial purity Nickel, commercial purity Nickel 200 Thon-300 Hanconel 625 59.00-34.50 Nickel 200 Inconel 625 59.00-88.00 Monel 400 15.00-33.00 Hayar Hayar 44.00-54.00 Super invar Kovar 50.00-66.00 Chemical lead Ingot Ingot 1.50-2.00 Plate 2.15-4.40 Antimonial lead (6%) Ingot 1.50-2.00 Plate 3.10-6.10 Tin, commercial purity, ingot or anode Zinc, commercial purity, ingot or anode Zirconium, reactor grade 702, plate 46.00-88.00 GRAPHITE, CERAMICS, AND SEMICONDUCTING MATERI Aluminum oxide Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm Ball grinding media, 90% pure, ½ in. dia. O.05 Diamond Natural, piode		ALLOYS	TITANIUM A
• ASTM grade 2, annealed Alloy Ti-5Al-2.5Sn 110.00-120.00 Alloy Ti-5Al-2.5Sn 110.00-120.00 Alloy Ti-6Al-4V 66.00-154.00 FRECIOUS METALS Gold, bullion 18,600-20,900 32,100-40,000 Silver, bullion 32,100-40,000 Silver, bullion 350-450 FREFRACTORY METALS Molybdenum, commercial purity 180-300 Alloy Tantalum, commercial purity 400-420 Tungsten, commercial purity 2225 FREFRACTORY METALS Miscellaneous Nonferrous Alloys Noisele, commercial purity 35,00-74.00 Silver, bullion 35,0			
Alloy Ti-5Al-2.5Sn Alloy Ti-6Al-4V PRECIOUS METALS Gold, bullion Platinum, bullion Silver, bullion Silver, bullion REFRACTORY METALS Molybdenum, commercial purity Tantalum, commercial purity Tantalum, commercial purity Tungsten, commercial purity Tungsten, commercial purity Tungsten, commercial purity Nickel 200 Silver, bullion Silver, bullion Nickel 200 Silver, bullion Silver, bullion Silver, bullion MISCELLANEOUS NONFEROUS ALLOYS Nickel, commercial purity Silver, bullion Silver, b	85.6	100.00-120.00	
PRECIOUS METALS	95.9	90.00-160.00	
PRECIOUS METALS	89.3		
Gold, bullion 18,600–20,900 Platinum, bullion 32,100–40,000 Silver, bullion 32,100–40,000 Silver, bullion 350–450	94.2	66.00–154.00	Alloy Ti-6Al-4V
Platinum, bullion 32,100–40,000 REFRACTORY METALS Molybdenum, commercial purity 180–300 Tantalum, commercial purity 400–420 Tungsten, commercial purity 2225 MISCELLANEOUS NONFERROUS ALLOYS Nickel, commercial purity 25,00–34,50 Nickel, 200 35,00–74,00 Inconel 625 59,00–88,00 Monel 400 15,00–33,00 Haynes alloy 25 143,00–165,00 Invar 44,00–54,00 Super invar 44,00 Kovar 50,00–66,00 Chemical lead • Ingot 2,15–4,40 • Plate 2,15–4,40 Antimonial lead (6%) • Plate 2,15–4,40 Antimonial lead (6%) • Plate 3,10–6,10 Tin, commercial purity 9,75–10,75 Solder (60Sn–40Pb), bar 8,10–16,50 Zirco, commercial purity, ingot or anode 2,00–4,65 Zirconium, reactor grade 702, plate 46,00–88,00 GRAPHITE, CERAMICS, AND SEMICONDUCTING MATERI		METALS	PRECIOUS I
Silver, bullion REFRACTORY METALS	15,300	18,600-20,900	Gold, bullion
Molybdenum, commercial purity 180–300 180–300 400–420 Tungsten, commercial purity 225	28,400	32,100-40,000	Platinum, bullion
Molybdenum, commercial purity 180–300 Tantalum, commercial purity 400–420 MISCELLANEOUS NONFERROUS ALLOYS Nickel, commercial purity 25.00–34.50 Nickel 200 35.00–74.00 Inconel 625 59.00–88.00 Monel 400 15.00–33.00 Haynes alloy 25 143.00–165.00 Invar 44.00–54.00 Kovar 50.00–66.00 Chemical lead • Ingot 1.50–2.00 • Plate 2.15–4.40 Antimonial lead (6%) • Ingot 2.30–3.90 • Plate 3.10–6.10 Tin, commercial purity 9.75–10.75 Solder (60Sn–40Pb), bar 8.10–16.50 Zinc, commercial purity, ingot or anode 2.00–4.65 Zircconium, reactor grade 702, plate 46.00–88.00 GRAPHITE, CERAMICS, AND SEMICONDUCTING MATERIAL Aluminum oxide • Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm 1.85–2.80 • Ball grinding media, 90% pure, ¼ in. dia. 39.00–52.00 • Ball grinding media, 90% pure, ¼ in. dia. 39.00–52.00 • Ball gr	313		Silver, bullion
Tantalum, commercial purity Tungsten, commercial purity MISCELLANEOUS NONFERROUS ALLOYS Nickel, commercial purity Nickel, commercial purity Nickel 200 Subscript		Y METALS	REFRACTORY
Tantalum, commercial purity Tungsten, commercial purity MISCELLANEOUS NONFERROUS ALLOYS Nickel, commercial purity Nickel, commercial purity Nickel 200 Subscript	161	180–300	Molybdenum, commercial purity
Tungsten, commercial purity 225	318	400–420	
Nickel, commercial purity 25.00–34.50 Nickel 200 35.00–74.00 Inconel 625 59.00–88.00 Monel 400 15.00–33.00 Haynes alloy 25 143.00–165.00 Invar 44.00–54.00 Super invar 44.00 Kovar 50.00–66.00 Chemical lead • Ingot • Ingot 1.50–2.00 • Plate 2.30–3.90 • Plate 3.10–6.10 Tin, commercial purity 9.75–10.75 Solder (60Sn–40Pb), bar 8.10–16.50 Zinc, commercial purity, ingot or anode 2.00–4.65 Zirconium, reactor grade 702, plate 46.00–88.00 GRAPHITE, CERAMICS, AND SEMICONDUCTING MATERI. Aluminum oxide • Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm 1.85–2.80 • Ball grinding media, 99% pure, ¼ in. dia. 33.00 • Ball grinding media, 99% pure, ¼ in. dia. 33.00 • Ball grinding media, 90% pure, ¼ in. dia. 16.00 Concrete, mixed 0.05 Diamond • Synthetic, 30–40 mesh, industrial grade 7700 • Natural, powder, 45 μm, polishing abrasive 2	175	225	
Nickel 200 35.00-74.00 Inconel 625 59.00-88.00 Monel 400 15.00-33.00 Haynes alloy 25 143.00-165.00 Invar 44.00-54.00 Super invar 44.00 Kovar 50.00-66.00 Chemical lead • Ingot 1.50-2.00 • Plate 2.15-4.40 Antimonial lead (6%) • Ingot 2.30-3.90 • Plate 3.10-6.10 Tin, commercial purity 9.75-10.75 Solder (60Sn-40Pb), bar 8.10-16.50 Zinc, commercial purity, ingot or anode 2.00-4.65 Zirconium, reactor grade 702, plate 46.00-88.00		FERROUS ALLOYS	MISCELLANEOUS NON
Nickel 200 Inconel 625 Inconel 626 Inconel 626 Invar Invar Invar Invar Invar Invar Invar Invar Inconel 626 Invar Invar Ingot	23.7	25.00-34.50	Nickel, commercial purity
Monel 400 15.00–33.00 Haynes alloy 25 143.00–165.00 Invar 44.00–54.00 Super invar 44.00 Kovar 50.00–66.00 Chemical lead • Ingot • Plate 2.15–4.40 Antimonial lead (6%) • Ingot • Plate 3.10–6.10 Tin, commercial purity 9.75–10.75 Solder (60Sn–40Pb), bar 8.10–16.50 Zinc, commercial purity, ingot or anode 2.00–4.65 Zirconium, reactor grade 702, plate 46.00–88.00 GRAPHITE, CERAMICS, AND SEMICONDUCTING MATERIAL Aluminum oxide • Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm 1.85–2.80 • Ball grinding media, 99% pure, ¼ in. dia. 39.00–52.00 • Ball grinding media, 96% pure, ¼ in. dia. 33.00 • Ball grinding media, 90% pure, ¼ in. dia. 16.00 Concrete, mixed 0.05 Diamond Synthetic, 30–40 mesh, industrial grade 7700 • Natural, powder, 45 μm, polishing abrasive 2300 • Natural, industrial, ½ carat 50,000–85,000	46.8	35.00-74.00	
Haynes alloy 25 Invar Invar 44.00–54.00 Super invar Kovar 50.00–66.00 Chemical lead Ingot Plate 1.50–2.00 Plate Antimonial lead (6%) Ingot Plate 1.50–3.90 Plate 3.10–6.10 Tin, commercial purity Plate 3.10–6.10 Tin, commercial purity Plate 3.10–6.10 Tin, commercial purity Plate 3.10–6.50 Zinc, commercial purity, ingot or anode Zinc, commercial purity, ingot or anode Zirconium, reactor grade 702, plate GRAPHITE, CERAMICS, AND SEMICONDUCTING MATERIAL Aluminum oxide Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm Ball grinding media, 99% pure, ¼ in. dia. Ball grinding media, 99% pure, ¼ in. dia. Ball grinding media, 96% pure, ¼ in. dia. Ball grinding media, 90% pure, ¾ in. dia.	55.5	59.00-88.00	Inconel 625
Haynes alloy 25 Invar Invar Super invar Kovar Chemical lead Ingot Plate Plate Antimonial lead (6%) Ingot Plate Ingot Plate Antimonial lead (6%) Ingot Plate In, commercial purity Solder (60Sn–40Pb), bar Zinc, commercial purity, ingot or anode Zinc, commercial purity, ingot or anode Zinc, commercial purity, ingot or anode Zinconium, reactor grade 702, plate In the super leading to the	16.8	15.00-33.00	Monel 400
Invar 44.00–54.00 Super invar 44.00 Super invar 44.00 Kovar 50.00–66.00 Chemical lead • Ingot 1.50–2.00 • Plate 2.15–4.40 Antimonial lead (6%) • Ingot 2.30–3.90 • Plate 3.10–6.10 Tin, commercial purity 9.75–10.75 Solder (60Sn–40Pb), bar 8.10–16.50 Zinc, commercial purity, ingot or anode 2.00–4.65 Zirconium, reactor grade 702, plate 46.00–88.00	120		
Super invar 44.00 Kovar 50.00-66.00 Chemical lead • Ingot • Plate 2.15-4.40 Antimonial lead (6%) • 1ngot • Plate 3.10-6.10 Tin, commercial purity 9.75-10.75 Solder (60Sn-40Pb), bar 8.10-16.50 Zinc, commercial purity, ingot or anode 2.00-4.65 Zirconium, reactor grade 702, plate 46.00-88.00 GRAPHITE, CERAMICS, AND SEMICONDUCTING MATERIA Aluminum oxide • Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm 1.85-2.80 • Ball grinding media, 99% pure, ¼ in. dia. 39.00-52.00 • Ball grinding media, 99% pure, ¼ in. dia. 33.00 • Ball grinding media, 96% pure, ¼ in. dia. 16.00 Concrete, mixed 0.05 Diamond • Synthetic, 30-40 mesh, industrial grade 7700 • Natural, powder, 45 μm, polishing abrasive 2300 • Natural, industrial, ½ carat 50,000-85,000	37.2		
Kovar 50.00–66.00 Chemical lead • Ingot 1.50–2.00 • Plate 2.15–4.40 Antimonial lead (6%) • Ingot 2.30–3.90 • Plate 3.10–6.10 Tin, commercial purity 3.10–6.10 Tin, commercial purity 9.75–10.75 Solder (60Sn–40Pb), bar 8.10–16.50 Zinc, commercial purity, ingot or anode 2.00–4.65 Zirconium, reactor grade 702, plate 46.00–88.00 GRAPHITE, CERAMICS, AND SEMICONDUCTING MATERIA Aluminum oxide • Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm 1.85–2.80 • Ball grinding media, 99% pure, ¼ in. dia. 39.00–52.00 • Ball grinding media, 96% pure, ¼ in. dia. 33.00 • Ball grinding media, 96% pure, ¼ in. dia. 16.00 Concrete, mixed 0.05 Diamond • Synthetic, 30–40 mesh, industrial grade 7700 • Natural, powder, 45 μm, polishing abrasive 2300 • Natural, industrial, ½ carat 50,000–85,000	34.2		
Chemical lead Ingot Plate Plate 1.50–2.00 Plate 2.15–4.40 Antimonial lead (6%) Ingot Plate 2.30–3.90 Plate 3.10–6.10 Tin, commercial purity 9.75–10.75 Solder (60Sn–40Pb), bar Rander (60Sn–4	44.3		
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Antimonial lead (6%) • Ingot • Plate Tin, commercial purity Solder (60Sn–40Pb), bar Zinc, commercial purity, ingot or anode Zinc, commercial purity, ingot or anode Zirconium, reactor grade 702, plate Calcined powder, 99.8% pure, particle size between 0.4 and 5 µm Ball grinding media, 99% pure, ¼ in. dia. Ball grinding media, 96% pure, ¼ in. dia. Ball grinding media, 90% pure, ¼ in. dia. Ball grinding media, 90% pure, ¼ in. dia. Synthetic, 30–40 mesh, industrial grade Natural, powder, 45 µm, polishing abrasive Natural, industrial, ¼ carat 2.30–3.90 2.30–3.90 2.30–3.90 2.30–3.90 2.30–3.90 2.30–3.00 2.00–4.65 2	2.5		•
 Ingot Plate 3.10-6.10 Tin, commercial purity 9.75-10.75 Solder (60Sn-40Pb), bar 8.10-16.50 Zinc, commercial purity, ingot or anode 2.00-4.65 Zirconium, reactor grade 702, plate 46.00-88.00 GRAPHITE, CERAMICS, AND SEMICONDUCTING MATERIA Aluminum oxide Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm Ball grinding media, 99% pure, ¼ in. dia. Ball grinding media, 96% pure, ¼ in. dia. Ball grinding media, 90% pure, ¼ in. dia. Ball grinding media, 90% pure, ¼ in. dia. Concrete, mixed O.05 Diamond Synthetic, 30-40 mesh, industrial grade Natural, powder, 45 μm, polishing abrasive Natural, industrial, ½ carat 50,000-85,000 	2.3	2.13	
 Plate	2.4	2 30_3 90	
Tin, commercial purity Solder (60Sn–40Pb), bar Solder (80Sn–40Pb), bar Solder (80Sn–40Sn Solder (80Sn–40Pb), bar Solder (80Sn	3.4		
Solder (60Sn–40Pb), bar Zinc, commercial purity, ingot or anode Zirconium, reactor grade 702, plate CRAPHITE, CERAMICS, AND SEMICONDUCTING MATERIA Aluminum oxide Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm Ball grinding media, 99% pure, ¼ in. dia. Ball grinding media, 96% pure, ¼ in. dia. Ball grinding media, 90% pure, ¼ in. dia. Ball grinding media, 90% pure, ¼ in. dia. Solution Solution Solution Tolo Natural, powder, 45 μm, polishing abrasive Natural, industrial, ½ carat Solution 8.10–16.50 2.00–4.65 46.00–88.00 1.85–2.80 2.000–52.00 50,000–85,000	8.0		
Zinc, commercial purity, ingot or anode Z.00–4.65 Zirconium, reactor grade 702, plate 46.00–88.00	9.4		
Zirconium, reactor grade 702, plate GRAPHITE, CERAMICS, AND SEMICONDUCTING MATERIA Aluminum oxide Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm Ball grinding media, 99% pure, ¼ in. dia. Ball grinding media, 96% pure, ¼ in. dia. Ball grinding media, 90% pure, ¼ in. dia. Ball grinding media, 90% pure, ¼ in. dia. Concrete, mixed O.05 Diamond Synthetic, 30–40 mesh, industrial grade Natural, powder, 45 μm, polishing abrasive Natural, industrial, ½ carat CERAMICS, AND SEMICONDUCTING MATERIA 1.85–2.80 23.00 50,000–85,000	2.8		
GRAPHITE, CERAMICS, AND SEMICONDUCTING MATERIA Aluminum oxide • Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm • Ball grinding media, 99% pure, ¼ in. dia. • Ball grinding media, 96% pure, ¼ in. dia. • Ball grinding media, 96% pure, ¼ in. dia. • Ball grinding media, 90% pure, ¼ in. dia. • Ball grinding media, 90% pure, ¼ in. dia. Concrete, mixed O.05 Diamond • Synthetic, 30–40 mesh, industrial grade • Natural, powder, 45 μm, polishing abrasive • Natural, industrial, ½ carat 50,000–85,000	52.2		
Aluminum oxide • Calcined powder, 99.8% pure, particle size between 0.4 and 5 μ m • Ball grinding media, 99% pure, ½ in. dia. • Ball grinding media, 96% pure, ½ in. dia. • Ball grinding media, 90% pure, ½ in. dia. • Ball grinding media, 90% pure, ½ in. dia. • Concrete, mixed Concrete, mixed • Synthetic, 30–40 mesh, industrial grade • Natural, powder, 45 μ m, polishing abrasive • Natural, industrial, ½ carat • S0,000–85,000	IALS	MICONDUCTING MATERIA	GRAPHITE, CERAMICS, AND SEM
 Calcined powder, 99.8% pure, particle size between 0.4 and 5 μm Ball grinding media, 99% pure, ¼ in. dia. Ball grinding media, 96% pure, ¼ in. dia. Ball grinding media, 96% pure, ¼ in. dia. Ball grinding media, 90% pure, ¼ in. dia. Concrete, mixed Diamond Synthetic, 30–40 mesh, industrial grade Natural, powder, 45 μm, polishing abrasive Natural, industrial, ½ carat 50,000–85,000 			
between 0.4 and 5 μ m			
• Ball grinding media, 99% pure, ¼ in. dia. 39.00–52.00 • Ball grinding media, 96% pure, ¼ in. dia. 33.00 • Ball grinding media, 90% pure, ¼ in. dia. 16.00 Concrete, mixed 0.05 Diamond • Synthetic, 30–40 mesh, industrial grade 7700 • Natural, powder, 45 μ m, polishing abrasive 2300 • Natural, industrial, ½ carat 50,000–85,000	1.8	1.85-2.80	
 Ball grinding media, 96% pure, ¼ in. dia. Ball grinding media, 90% pure, ¼ in. dia. Concrete, mixed Diamond Synthetic, 30–40 mesh, industrial grade Natural, powder, 45 μm, polishing abrasive Natural, industrial, ½ carat 50,000–85,000 	35.1		
 Ball grinding media, 90% pure, ¼ in. dia. Concrete, mixed Diamond Synthetic, 30–40 mesh, industrial grade Natural, powder, 45 μm, polishing abrasive Natural, industrial, ½ carat 50,000–85,000 	25.6		
Concrete, mixed 0.05 Diamond • Synthetic, 30–40 mesh, industrial grade 7700 • Natural, powder, 45 µm, polishing abrasive 2300 • Natural, industrial, ½ carat 50,000–85,000	12.4		
Diamond • Synthetic, 30–40 mesh, industrial grade • Natural, powder, 45 μm, polishing abrasive • Natural, industrial, ½ carat 50,000–85,000	0.04		
 Synthetic, 30–40 mesh, industrial grade Natural, powder, 45 μm, polishing abrasive Natural, industrial, ½ carat 7700 2300 50,000–85,000 	0.01		
 Natural, powder, 45 μm, polishing abrasive Natural, industrial, ½ carat 2300 50,000–85,000 	6000	7700	
• Natural, industrial, ½ carat 50,000–85,000	1800		
	52,400		
~ ······ ···· ··· ··· ··· ··· ··· ··· ·	52,100	20,000 02,000	
• Mechanical grade, 75-mm-dia. wafers, ~625 μm thick 3900	3000	3900	
 Prime grade, 75-mm-dia. Wafers, ~625 μm thick 6500 	5000		

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Material/Condition	Cost (\$US/kg)	Relative Cost
Glass, borosilicate (Pyrex), plate	9.20-11.30	7.9
Glass, soda–lime, plate	0.56-1.35	0.7
Glass-ceramic (Pyroceram), plate	12.65–16.55	11.3
Graphite		
• Powder, synthetic, 99+% pure, particle	1.80-7.00	3.1
size, ~10 μm		
 Isostatically pressed parts, high purity, ~20-μm particle size 	50.00–125.00	65.3
Silica, fused, plate	1200-1700	1100
Silicon		
• Test grade, undoped, 100-mm-dia. wafers, ~425 μm thick	5100–9000	5500
• Prime grade, undoped, 100-mm-dia. wafers, ~425 µm thick	8000-14,000	8800
Silicon carbide		
• α-phase ball grinding media, ¼ in. dia., sintered	250.00	194
Silicon nitride		
 Powder, submicron particle size 	100–200	100
• Balls, finished ground, 0.25 in. to 0.50 in.		
diameter, hot isostatically pressed	1000-4000	1600
Zirconia (5 mol% Y ₂ O ₃), 15-mm-dia. ball	50–200	97.1
grinding media		
POLY	MEDS	
Butadiene-acrylonitrile (nitrile) rubber	VIERS	
• Raw and unprocessed	4.00	3.1
• Extruded sheet (¼–½ in. thick)	8.25	6.4
• Calendered sheet (¼–¼ in. thick)	5.25–7.40	4.9
Styrene-butadiene (SBR) rubber	0.20 ////	>
• Raw and unprocessed	1.70	1.3
• Extruded sheet (1/4–1/8 in. thick)	5.05	3.9
• Calendered sheet (¼–¼ in. thick)	3.25–3.75	2.7
Silicone rubber		
Raw and unprocessed	9.90-14.00	9.5
• Extruded sheet (¼–¼ in. thick)	28.00-29.50	22.4
• Calendered sheet (¼–¼ in. thick)	7.75–12.00	7.7
Epoxy resin, raw form	2.20-2.80	1.9
Nylon 6,6		
• Raw form	3.20-4.00	2.8
• Extruded	12.80	9.9
Phenolic resin, raw form	1.65–1.90	1.4
Poly(butylene terephthalate) (PBT)		
• Raw form	4.00-7.00	4.3
• Sheet	40.00-100.00	54.3
Polycarbonate (PC)		
• Raw form	3.00-4.70	2.9
• Sheet	10.50	8.2
Polyester (thermoset), raw form	3.10-4.30	2.7
Polyetheretherketone (PEEK), raw form	90.00-105.00	76.0
Polyethylene		
• Low density (LDPE), raw form	1.60–1.85	1.3
 High density (HDPE), raw form 	1.20–1.75	1.2
 Ultrahigh molecular weight (UHMWPE), 	2.20-3.00	2.1
raw form		

Appendix C / Costs and Relative Costs for Selected Engineering Materials · A35

Material/Condition	Cost (\$US/kg)	Relative Cost
Poly(ethylene terephthalate) (PET)		
• Raw form	1.50-1.75	1.3
• Sheet	3.30-5.40	3.4
Poly(methyl methacrylate) (PMMA)		3.1
• Raw form	2.60-5.40	3.1
• Extruded sheet (¼ in. thick)	4.65–6.05	4.1
Polypropylene (PP), raw form	1.05-1.70	1.2
Polystyrene (PS), raw form	1.55–1.95	1.4
Polytetrafluoroethylene (PTFE)		
• Raw form	14.80–16.90	11.9
• Rod	21.00	16.3
Poly(vinyl chloride) (PVC), raw form	1.10–1.85	1.2
FIBER MA	TERIALS	
Aramid (Kevlar 49), continuous	35.00–100.00	38.8
Carbon (PAN precursor), continuous		
Standard modulus	40.00-80.00	48.1
 Intermediate modulus 	60.00-130.00	69.1
High modulus	220.00-275.00	193
E-glass, continuous	1.55–2.65	1.6
COMPOSITE N	MATERIALS	
Aramid (Kevlar 49) continuous-fiber, epoxy prepreg	75.00–100.00	66.8
Carbon continuous-fiber, epoxy prepreg		
 Standard modulus 	49.00–66.00	43.1
 Intermediate modulus 	75.00–240.00	123
High modulus	120.00-725.00	330
E-glass continuous-fiber, epoxy prepreg	24.00-50.00	28.3
Woods		
• Douglas fir	0.61-0.97	0.6
 Ponderosa pine 	1.15–1.50	1.0
 Red oak 	3.35–3.75	2.8