Appendix E: Material properties

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This appendix presents tables that compare the physical and mechanical properties of some of the most popular materials for additive manufacturing. The first table provides common manufacturing materials for the purpose of comparison. These 51 pages are private and not published elsewhere. Please note that these tables were last updated in February 2015. Consider also senvol.com/database to review the properties of AM materials.

Description	ABS (acrylonitrile butadiene styrene)	Nylon 66	Polycarbonate	PVC (polyvinylchloride)	Polypropylene
Tensile strength (ASTM D638) lb/in^2 (MPa)	6,628 (46)	9,224 (63.6)	9,065 (62.5)	5,000-9,000 (34-62)	4,500-5,400 (31-37)
Tensile modulus (ASTM D638) lb/in^2 (MPa)	290,000 (2,000)	305,000 (2,100)	334,000 (2,300)	350,000-600,000 (2,400-4,100)	170,000-250,000 (1,172-1,724)
Elongation % at break	41.6	82.8	110	3-120	7-13
Elongation % at yield	N/A	10.7%	6%	N/A	N/A
Impact strength (notched Izod) ft-lb/in of notch (J/m)	1.7-4.5 (0.9 -2.4)	0.75-24.4 (0.4-13)	0.93-18 (0.5-10)	0.75-20 (0.4-10.1)	0.4-1.4 (21-75)
Hardness	75-115 Rockwell (R)	93-122 Rockwell (R)	118-133 Rockwell (R)	70 Shore (D)	68-83 Shore (D)
Glass-transition temperature °C (Heat-deflection temperature °C)	N/A (94-194)	N/A (80-210)	150 (130)	N/A (66-89)	130-168 (107-121)

Source: www.matweb.com and CADCAMNet

Note: Ryan Wicker, David Roberson, and David Espalin contributed to this appendix.

Process	Material extrusion						
Manufacturer	Stratasys Ltd. (1 of 2)						
Material	ABS	ABSi	ASA	Polycarbonate (PC)	Polycarbonate ISO	Polyphenylsulfone (PPSF)	PC-ABS
Type of material	acrylonitrile butadiene styrene filament	methyl methacrylate acrylonitrile butadiene styrene filament	thermoplastic	polycarbonate filament	polycarbonate filament	polyphenyl sulfone filament	polycarbonate/ acrylonitrile butadiene styrene blend filament
Type of machine	Dimension, Maxum, Titan, Vantage SE, Vantage S, Vantage I, (when configured with ABS) Prodigy Plus, Fortus 360mc, 400mc	Dimension, Maxum, Titan TI, Vantage SE, Vantage S, Vantage I, (when configured with ABS) Prodigy Plus, Fortus 400mc, 380mc, 450mc, 900mc	Fortus 360mc, 400mc, 380mc, 450mc, 900mc	Titan, Vantage S, Vantage SE, Vantage I, (when configured with PC), Fortus 360mc, 400mc, 900mc	Titan, Vantage S, Vantage SE, Fortus 400mc, 380mc, 450mc, 900mc	Titan, Fortus 400mc, 900mc	Titan, Vantage S, Vantage SE, Fortus 360mc, 400mc, 900mc
Notes	durable, strong, good heat and chemical resistance; comes in colors	can be sterilized with gamma radiation	UV-stable	very tough thermoplastic, commonly used for manufacturing	complies with ISO-10993 and USP Class VI medical classifications for biocompatibility	very tough thermoplastic, commonly used for manufacturing	this blend combines the most desirable properties of both materials
Physical properties							
Tensile strength (ASTM D638) lb/in^2 (MPa)	3,200 (22)	5,400 (37)	4,200 (29)	9,800 (68)	8,300 (57)	8,000 (55)	4,250 (29)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	236,000 (1,027)	277,700 (1,920)	290,000 (2,010)	330,000 (2,300)	289,800 (2,000)	300,000 (2,100)	260,000 (1,810)
Elongation (ASTM D638) % at yield	6	4.4	2	5	4	3	2
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	2.0 (107)	1.8 (96.4)	1.2 (64)	1 (53)	1.6 (86)	1.1 (58.7)	4 (235)
Hardness (Rockwell)	R105	R108	82	R115	N/A	M86	R110
General information							
Glass-transition temperature °C	104	116	108	161	161	230	125
Heat-deflection temperature °C @66 psi @264 psi	90 76	86 73	98 91	138 127	133 127	N/A 189	110 96

Source: Materials Sheets, Stratasysredeyeondemand.com/Materials_FDM_Thermoplastics.aspx, February 2015

Process	Material extrusion						
Manufacturer	Stratasys Ltd. (2 of 2)						
Material	ABS-M30	ABS-M30i	ABS Plus	ULTEM 9085	ULTEM 1010	ABS-ESD7	FDM Nylon 12
Type of material	ABS with improved strength	ABS with improved strength and biocompatibility	ABS with improved strength	thermoplastic	high-temperature thermoplastic	ABS thermoplastic	production-grade thermoplastic
Type of machine	Fortus 400mc, 360mc, 380mc, 450mc, 400mc, 900mc	Fortus 400mc, 380mc, 450mc, 900mc	FDM 200mc, Fortus 200mc	Fortus 400mc, 450mc, 900mc	Fortus 900mc	Fortus 400mc, 380mc, 450mc, 900mc	Fortus 900mc, 400mc, 360mc, 380mc, 450mc
Notes	greater tensile, impact, and flexural strength than standard ABS filament, 25-70% improved strength over standard ABS	high strength, biocompatible (ISO 10993 certified), can be gamma or EtO sterilized, good mechanical properties	blend combines the most desirable properties of both materials, up to 40% improved strength over standard ABS	flame retardant, high strength to weight ratio, FST rating, ideal for the transportation industry	high heat resistance, chemical resistance, and tensile strength; NSF 51 food-contact certification	static dissipative properties, prevents buildup of static electricity, ideal for electronic products with circuit boards	offers the best *z*-lamination and highest impact strength of any FDM thermoplastic, as well as excellent chemical resistance
Physical properties							
Tensile strength (ASTM D638) lb/in^2 (MPa)	4,450 (31)	4,550 (31)	5,300 (37)	10,400 (71.6)	11,735 (81)	5,200 (36)	7,000 (48)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	320,000 (2,230)	320,000 (2,230)	330,000 (2,320)	322,000 (2,200)	402,000 (2,772)	350,000 (2,400)	190,000 (1,310)
Elongation (ASTM D638) % at yield	2	2	3	6	2.2	3	6.5
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	2.4 (128)	2.4 (128)	2.0 (106)	2.0 (106)	0.8 (41)	0.5 (28)	3.7 (200)
Hardness (Rockwell)	109.5	109.5	N/A	N/A	109	109.5	N/A
General information							
Glass-transition temperature °C	108	108	108	186	215	108	N/A
Heat-deflection temperature °C @66 psi @264 psi	96 82	96 82	96 82	N/A 153	216 213	96 82	75 55

Source: Materials Sheets, Stratasys, redeyeondemand.com/Materials_FDM_Thermoplastics.aspx, February 2015

Process	Material jetting					
Manufacturer	Stratasys Ltd. (1 of 2)					
Material	Vero Family	VeroBlue RGD840	RGD720	VeroClear RGD810	DurusWhite RGD430	Endur RGD450
Type of material	photopolymer resin					
Type of machine	Desktop, Eden, and Connex families		some Desktop family, most Eden family, all Connex family			
Notes	general-purpose rigid, opaque		transparent		simulated polypropylene materials; tough; snap-fit and living hinge applications	
Physical properties						
Tensile strength (ASTM D638) lb/in^2 (MPa)	7,250-9,450 (50-65)	7,250-8,700 (50-60)	7,250-9450 (50-65)	7,250-9450 (50-65)	2,900-4,350 (20-30)	5,800-6,500 (40-45)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	290,000-435,000 (2,000-3,000)	290,000-435,000 (2,000-3,000)	290,000-435,000 (2,000-3,000)	290,000-435,000 (2,000-3,000)	145,000-175,000 (1,000-1,200)	246,000-305,000 (1,700-2,100)
Elongation (ASTM D638) % at yield	10-25 (at break)	15-25 (at break)	15-25 (at break)	10-25 (at break)	40-50 (at break)	20-35 (at break)
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	0.375-0.562 (20-30)	0.375-0.562 (20-30)	0.375-0.562 (20-30)	0.375-0.562 (20-30)	0.749-0.937 (40-50)	0.561-0.656 (30-35)
Hardness (Shore D-scale)	83-86	83-86	83-86	83-86	74-78	80-84 (Shore A)
General information						
Glass-transition temperature°C	52-54	48-50	48-50	52-54	95-99	48-52

Source: PolyJet Material Spec Sheet, http://www.stratasys.com/~/media/Main/Secure/Material%20Specs%20MS/PolyJet-Material-Specs/PolyJet_Materials_Data_Sheet.pdf, February 2015

Process	Material jetting				
Manufacturer	Stratasys Ltd. (2 of 2)				
Material	Digital ABS RDG515/535	RDG525	TangoBlackPlus FLX980, TangoPlus FLX930	TangoGray FLX950	TangoBlack FLX973
Type of material	photopolymer resin				
Type of machine	Connex family	some Desktop family, most Eden family, all Connex family			
Notes	ABS-like digital material, green or ivory	high-temperature material	rubber-like flexible black material	rubber-like flexible materials; black is slightly softer; gray is harder but still flexible	
Physical properties					
Tensile strength (ASTM D638) lb/in^2 (MPa)	8,000-8,700 (55-60)	10,000-11,500 (70-80)	115-220 (.8-1.5)	435-725 (3-5)	115-350 (1.8-2.4)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	375,000-435,000 (2,600-3,000)	465,000-510,000 (3,200-3,500)	N/A	N/A	N/A
Elongation (ASTM D638) % at yield	25-40	10-15	170-220 (at break)	45-55 (at break)	45-55 (at break)
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	1.22-1.50 (65-80)	0.262-0.300 (14-16)	N/A	N/A	N/A
Hardness (Shore D-scale)	85-87	87-88	26-28 (Shore A)	73-77 (Shore A)	60-62 (Shore A)
General information					
Glass-transition temperature°C	47-53	62-65	N/A	N/A	N/A

Source: PolyJet Material Spec Sheet, http://www.stratasys.com/~/media/Main/Secure/Material%20Specs%20MS/PolyJet-Material-Specs/PolyJet_Materials_Data_Sheet.pdf, February 2015

Process	Material jetting						
Manufacturer	Solidscape, a subsidiary of Stratasys Ltd. (1 of 1)						
Material	InduraCast	InduraFill	3Z Model	3Z Support	3Z Lab CAST	3Z Lab Fill	plusCAST
Type of material	thermoplastic	composition: natural and synthetic waxes and fatty esters	organic compound	wax blend	organic compound	wax blend	sulphonamide and benzoate derivatives with polyester resin
Type of machine	T66 Benchtop System, T612 Benchtop System, R66 System, 3Z Pro, 3Z Studio, 3Z Lab, 3Z Edu						
Notes	melting point: 221-239°F (95-115°C); coefficient of thermal expansion negligible; no residue after autoclave process; no shrinkage; non-toxic; distortion disintegration at normal temperatures	melting point: 121-162°F (50-72°C); soluble in a mineral oil bath at 122-131°F (50-55°C); no post-dissolve dry or cure time; no post-dissolve finishing or touch up necessary; non-toxic	melting point: 221-239°F (95-115°C); non-toxic; registered by TSCA	low melting point: 121-162°F (50-72°C) non-toxic; registered by TSCA.; post-printing, the resulting structure dissolves in a liquid solution process	melting point: 221-239°F (95-115°C); non-toxic; registered by TSCA	low melting point: 121-162°F (50-72°C) non-toxic; registered by TSCA.; post-printing, the resulting structure dissolves in a liquid solution process	melting point of 221-239°F (95-115°C); non-toxic; clean burnout during casting with no residual ash or shrinkage, and thermal polyester formula produces strong molds
Physical properties							
Tensile strength (ASTM D638) lb/in^2 (MPa)	N/A						
Elastic modulus (ASTM D638) lb/in^2 (MPa)							
Elongation (ASTM D638) % at yield							
Impact strength (notched Izod) ft-lb/in of notch (J/m)							
Hardness (Shore D-scale)	65	45	N/A	N/A	N/A	N/A	N/A
General information							
Glass-transition temperature°C	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Source: Material Properties Sheet, Solidscape, Inc.

Process	Material jetting							
Manufacturer	3D Systems (1 of 3)							
Material	VisiJet SL Flex	VisiJet SL Tough	VisiJet SL Clear	VisiJet SL Black	VisiJet SL Impact	VisiJet SL HiTemp	VisiJet SL e-Stone	VisiJet SL Jewel
Type of material	UV curable plastic							
Type of machine	ProJet 6000 and 7000 (SD, HD, MP)							
Notes	high flexibility and shape retention	high durability and impact strength	crystal clear appearance, stiff and durable	high strength and good dimensional stability	tough and durable, ideal for functional assemblies	humidity and chemically resistant with high rigidity, long term stable properties	ideal for crown and bridge restorations	models requiring high detail, resolution, and accuracy
Physical properties								
Tensile strength (ASTM D638) lb/in^2 (MPa)	5,511 (38)	5,945 (41)	7,542 (52)	6,527 (45)	6,962 (48)	9,572 (66)	5,511 (38)	5,800 (40)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	234,961 (1,620)	274,121 (1,890)	371,297 (2,560)	311,831 (2,150)	380,869 (2,626)	491,678 (3,390)	236,411 (1,630)	277,022 (1,910)
Elongation (ASTM D638) % at yield	16 (% at break)	18 (% at break)	6 (% at break)	5 (% at break)	14 (% at break)	6 (% at break)	17 (% at break)	12 (% at break)
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	22	44	46	47	65	26	22	45
Hardness (Shore D-scale)	80	86	85	86	80	86	80	72
General information								
Heat deflection temperature at 66 psi in °C	N/A							

Source: Product Data Sheets\ 3-D Printer Modeling Materials, 3D Systems, http://www.3dsystems.com/materials/professional, February 2015

Process	Material jetting				
Manufacturer	3D Systems (2 of 3)				
Material	VisiJet C4 Spectrum	VisiJet FTX Green	VisiJet M5-X	VisiJet M5-Black	VisiJet M5-MX
Type of material	heat-cured plastic composite	UV curable plastic	UV-curable liquid plastic		
Type of machine	ProJet 4500	ProJet 1200	ProJet 5000		
Physical properties					
Tensile strength (ASTM D638) lb/in^2 (MPa)	3,742 (26)	4,351 (30)	5,715 (39.4)	4,757 (32.8)	4,496 (31)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	232,060 (1,600)	246,564 (1700)	279,197 (1,925)	225,533 (1,555)	183,763 (1,267)
Elongation (ASTM D638) % at yield	3.6 (% at break)	10 (% at break)	7.8 (% at break)	15.4 (% at break)	20 (% at break)
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	N/A				
Hardness (Shore D-scale)	79	N/A			
General information					
Heat deflection temperature at 66 psi in °C	N/A				

Source: Product Data Sheets\ 3-D Printer Modeling Materials, 3D Systems, http://www.3dsystems.com/materials/professional, February 2015

Process	Material jetting							
Manufacturer	3D Systems (3 of 3)							
Material	VisiJet M3 X	VisiJet M3 Black	VisiJet M3 Crystal	VisiJet M3 Propast	VisiJet M3 Navy	VisiJet M3 Techplast	VisiJet M3 Procast	VisiJet S300
Type of material	UV curable plastic							wax support material
Type of machine	ProJet 3510 (SD, HD, HD *Plus*) & 3500 HD *Max*							
Notes	tough, high temperature resistant, durable, stable, watertight, biocompatible, castable							
Physical properties								
Tensile strength (ASTM D638) lb/in^2 (MPa)	7,107 (49)	5,105 (35.2)	6,150 (42.4)	3,800 (26.2)	2.973 (20.5)	3,205 (22.1)	4,641 (32)	N/A
Elastic modulus (ASTM D638) lb/in^2 (MPa)	314,441 (2,168)	231,190 (1,594)	212,190 (1,463)	160,701 (1,108)	106,602 (735)	125,602 (866)	250,044 (1,724)	
Elongation (ASTM D638) % at yield	8.3 (at break)	19.7 (at break)	6.83 (at break)	8.97 (at break)	8 (at break)	6.1 (at break)	12.3 (at break)	
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	N/A							
Hardness (Shore D-scale)	80	86	85	86	80	86	80	
General information								
Heat deflection temperature at 66 psi in °C	N/A							

Source: Product Data Sheets\ 3-D Printer Modeling Materials, 3D Systems, http://www.3dsystems.com/materials/professional, February 2015

Process	Binder jetting			
Manufacturer	ExOne Company (1 of 1)			
Material name	S3	S4 (non-annealed)	S4 (annealed)	Alloy IN 625
Material (alloy family)	316 stainless steel and bronze	420 stainless steel and bronze	420 stainless steel and bronze	nickel-based superalloy
Notes	used in digital mold and core-making system	used in digital mold and core-making system	used in digital mold and core-making system	typically used in the aerospace industry high temperature parts
Physical properties				
Ultimate tensile strength ksi (MPa)	59 (406)	99 (682)	72 (496)	97-98 (669-676)
Yield stress ksi (MPa)	34 (234)	66 (455)	67 (462)	42-44 (290-303)
Hardness	60 HRB	20-25 HRC	30	84 HRB
Modulus MPSI (GPa)	21.5 (148)	21.4 (147)	21.4 (147)	28-29 (193-200)
Elongation (%)	8.0	2.3	7.0	41-51

Source: Material Data Sheets from ExOne Company, http://www.exone.com/Resources/Materials, February 2015. Information regarding other materials, including but not limited to copper, tungsten, and nickel, available upon request from ExOne.

Process	Sheet lamination				
Manufacturer	Fabrisonic LLC (1 of 1)				
Material	aluminum	aluminum	aluminum	aluminum	copper
Alloy/temper	1100 T0	3003 T0	3003 H18	6061 T0	101, 100 annealed
Type of machine	FORMation, SonicLayer R200, 4000, 7200				
General properties					
Density (g/cm^3)	2.71	2.73	2.73	2.70	8.96
Material	1100 T0	3003 T0	3003 H18	6061 T0	copper
Physical properties					
Ultimate tensile strength (Rm) lb/in^2 (MPa)	89.6	110	200	124	210
Yield strength (Rp 0.2) lb/in^2 (MPa)	34.5	41.4	186	55.2	33
Elongation (ASTM D638) % at break	35	30	4	25	70
Hardness (Brinell scale)	23	28	55	30	90
Modulus of elasticity (GPa)	68.9				110

Source: Product Data Sheets, Fabrisonic, http://www.fabrisonic.com/materials.html, February 2015

Process	Vat photopolymerization				
Manufacturer	3D Systems (1 of 4)				
Material	Accura Xtreme	Accura 60	Accura Bluestone	Accura 25	Accura 55
Type of material	photopolymer liquid resin				
Type of laser (machine)	solid-state lasers	solid-state lasers	solid-state lasers	solid-state lasers	solid-state lasers
Notes	the aesthetics and properties of a grey molded ABS production part with toughness and accuracy	durable, humidity resistance, optical clarity, view internal features and passages, low-viscosity formulation	engineering nanocomposite material, exceptional stiffness and thermal resistance, low shrinkage, high humidity resistance	durable white material, ideal for snap fits and RTV-molding applications	durable and rigid material, ABS-like, fast build speed
Postcure method	UV light	UV light	UV light and heat	UV light and heat	UV light and heat
Process properties – liquid resin					
Critical exposure E_c (mJ/cm^2)	11.7	7.6	6.9	10.5	7.4
Depth of penetration D_p (mils)	4.1	6.3	4.1	4.2	5.2
Viscosity centipoise at 30°C	250-300	150-180	1,200-1,800	250	155-185

Continued on the following page

Material	Accura Xtreme	Accura 60	Accura Bluestone	Accura 25	Accura 55
Physical properties					
Tensile strength lb/in^2 (MPa)	5,510-6,380 (38-44)	8,410-9,860 (58-68)	9,600-9,800 (66-68)	5,540-5,570 (38)	9,200-9,850 (63-68)
Tensile modulus lb/in^2 (MPa)	260,000-287,000 (1,790-1,980)	390,000-450,000 (2,690-3,100)	1,100,000-1,700,000 (7,600-11,700)	230,000-240,000 (1,590-1,660)	460,000-490,000 (3,200-3,380)
Elongation % at break	14-22	5-13	1.4-2.4	13-20	5-8
Impact strength (notched Izod) ft-lb/in of notch (J/m) @ ASTM D 256	0.66-0.98 (35-52)	0.3-0.5 (15-25)	0.24-0.32 (13-17)	0.4 (19-24)	0.2-0.4 (12-22)
Hardness (Shore D-scale)	86	86	92	80	85
General information					
Heat deflection temperature °C @66 lb/in^2 @264 lb/in^2	62 54	53-55 48-50	65-66 65	58-63 51-55	55-58 51-53
Glass-transition temperature °C	52	58°	71-83	60	56

Source: Accura Stereolithography Material Datasheets, 3D Systems, http://www.3dsystems.com/materials/production, February 2015

Process	Vat photopolymerization			
Manufacturer	3D Systems (2 of 4)			
Material	Accura Amethyst	Accura 48HTR	Accura PEAK	Accura E-Stone
Type of material	photopolymer liquid resin			
Type of laser (machine)	solid-state lasers			
Notes	purple, superior feature detail and part quality, highly accurate, good combination of speed and part quality	high humidity and moisture resistant, high rigidity, low viscosity formulation, thermally resistant to 130 °C	high stiffness, moisture resistant, elevated-temperature resistance, high accuracy	color selection availability, useful with dental lab practices, high accuracy and repeatability, increased visual detail, reduced breakage vs. plaster
Postcure method	UV light and heat	UV light		
Process properties – liquid resin				
Critical exposure E_c (mJ/cm^2)	14.4	7.4	11.5	10.5
Depth of penetration D_p (mils)	3.7	5.5	5.6	4.2
Viscosity centipoise at 30°C	350	200-250	605	200-300

Continued on the following page

Material	Accura Amethyst	Accura 48HTR	Accura PEAK	Accura E-Stone
Physical properties				
Tensile strength lb/in^2 (MPa)	3,130-5,450 (22-38)	9,280-9,720 (64-67)	8,270-11,320 (57-78)	5,400-5,600 (37-39)
Tensile modulus lb/in^2 (MPa)	260,000-287,000 (3,514-3,996)	406,000-577,000 (2,800-3,980)	612,000-695,000 (4,220-4,790)	220,000-250,000 (1,500-1,750)
Elongation % at break	.56-1.04	4-7	1.3-2.5	10-23
Impact strength (notched Izod) ft-lb/in of notch (J/m)	0.66-0.98 (9-12)	0.4-0.5 (22-29)	0.4-0.5 (21.3-27.3)	0.3-0.5 (18-25)
Hardness (Shore D-scale)	87	86	86	80
General information				
Heat deflection temperature °C @66 lb/in^2 @264 lb/in^2	77 62	65 57	153 124	58-63 51-55
Glass-transition temperature °C	103	62	104	60

Source: Accura Stereolithography Material Datasheets, 3D Systems, production3dprinters.com/materials/sla/, February 2015

Process	Vat photopolymerization				
Manufacturer	3D Systems (3 of 4)				
Material	Accura ClearVue	Accura Sapphire	Accura Xtreme White200	Accura CastPro	Accura CeraMAX Composite
Type of material	photopolymer liquid resin				
Type of laser (machine)	solid-state stereolithography SLA systems	Viper systems	solid-state stereolithography SLA systems		
Notes	high clarity and transparency, durable and strong, humidity and moisture stable	high accuracy, low ash formulation, high contrast deep blue color	exceptionally tough and durable, resists breakage, great for snap fits	low viscosity, humidity and moisture stable, good thermal expansion characteristics, fast photospeed	plastic-ceramic composite, high thermal resistance, moisture and abrasion resistant, high rigidity
Postcure method	UV light				
Process properties – liquid resin					
Critical exposure E_c (mJ/cm^2)	9.5	8.23	8.3	8.7	7.2
Depth of penetration D_p (mils)	6.1	2.9	4.6	6.2	5.7
Viscosity centipoise at 30°C	235-260	160-200	650-750	240-260	1,500-2,000

Continued on the following page

Material	Accura ClearVue	Accura Sapphire	Accura Xtreme White	Accura CastPro	Accura CeraMAX Composite
Physical properties					
Tensile strength lb/in^2 (MPa)	6,700-7,700 (46-53)	2,900-3,480 (20-24)	6,530-7,250 (45-50)	7,540-7,690 (52-53)	11,300-12,600 (78-87)
Tensile modulus lb/in^2 (MPa)	329,000-383,000 (2,270-2,640)	132,000-161,000 910-1110	334,000-381,000 (2,300-2,630)	361,000-380,000 (2,490-2,620)	1,370,000-1,400,000 (9,460-9,680)
Elongation % at break	3-15	9-16	7-20	4.1-8.3	1-1.5
Impact strength (notched Izod) ft-lb/in of notch (J/m)	0.70-1.1 (40-58)	0.5-0.7 (29-40)	1.03-1.04 (55-66)	0.80-0.92 (43-49.5)	0.27-0.34 (14.5-17.9)
Hardness (Shore D-scale)	80	72	78-80	85	89
General information					
Heat deflection temperature °C @66 lb/in^2 @264 lb/in^2	51 50	38 33	117 108	51 50	220 97
Glass-transition temperature °C	62	58	52	70	108-110

Source: Accura Stereolithography Material Datasheets, 3D Systems, production3dprinters.com/materials/sla/, February 2015

Process	Vat photopolymerization				
Manufacturer	3D Systems (4 of 4)				
Material	Accura CastPro Free SL-7800	Accura ABS White SL-7810	Accura ABS Black SL 7820	Accura SL 7840	Accura ClearVue Free SL 7870
Type of material	photopolymer liquid resin				
Type of laser	solid-state lasers ([1]SLA 3500, [2]SLA 5000, [3]SLA 7000, [4]Viper SLA, [5]SLA 500)				
Notes	general purpose resin excellent for QuickCast patterns, low viscosity, superior vat life	white, low viscosity, ABS-like appearance, suited for RTV patterns, durability past 6 months	builds black parts with ABS like finish, low viscosity and good green strength, good drainage for fast cleaning	high elongation and excellent flexibility, good dimensional stability, low viscosity, good green strength	high elongation and flexibility, low viscosity and good dimensional stability
Postcure method	UV light		UV light and heat		
Process properties – liquid resin					
Critical exposure E_c (mJ/cm^2)	9.51[1,4,5] 9.98[2,3]	9.9	10.0	15.0	10.6
Depth of penetration D_p (mils)	5.67[1,4,5] 5.74[2,3]	5.6	4.5	5.0	7.2
Viscosity centipoise at 30°C	205	210	210	270	180
Density g/cm^3 at 25°C	1.12	1.13	1.13	1.13	1.13

Continued on the following page

Material		Accura CastPro Free SL-7800	Accura ABS White SL-7810	Accura ABS Black SL 7820	Accura SL 7840	Accura ClearVue Free SL 7870
Physical properties						
Tensile strength (ASTM D638) lb/in^2 (MPa)	**UV postcure**	6,000-6,800 (41-47)	5,200-7,400 (36-51)	5,200-7,400 (36-51)	5,200-6,500 (36-45)	5,470-6,050 (38-42)
	UV plus heat	6,400 (44)	5,700-7,400 (39-51)	5,700-7,400 (39-51)	5,400-6,500 (37-45)	5,620-6,050 (39-42)
Tensile modulus (ASTM D638) lb/in^2 (MPa)	**UV postcure**	260,000-348,000 (1,800-2,400)	260,000-348,000 (1,800-2,400)	274,000-348,000 (1,900-2,400)	247,000-319,000 (1,700-2,200)	278,000-291,000 (1,930-2,020)
	UV plus heat	290,000-348,000 (2,000-2,400)	290,000-348,000 (2,000-2,400)	290,000-362,500 (2,000-2,500)	232,000-319,000 (1,600-2,200)	268,000-292,000 (1,860-2,030)
Elongation (ASTM D638) % at break	**UV postcure**	10-20	10-20	8-18	11-17	10-22
	UV plus heat	10-14	10-14	9-14	11-18	10-23
Impact strength (notched Izod) ft-lb/in of notch (J/m)	**UV postcure**	0.7-1.1 (37-58)	0.83-0.91 (44-48)	0.79-0.91 (42-48)	0.7-1.1 (37-60)	0.85-1.15 (45-61)
	UV plus heat	0.7-0.9 (37-48)	0.83-0.93 (44-49)	0.88-.93 (30-49)	0.66-1.1 (35-60)	0.81-1.13 (43-60)
Hardness (Shore D-scale)	**UV postcure**	87	86	86	86	86
	UV plus heat	87	87	87	87	87
General information						
Heat deflection temperature ˚C @66 lb/in^2 @264 lb/in^2	**UV postcure**	62 -	50 -	51 -	48 -	48 -
	UV plus heat	62 -	50 -	50 -	46 -	49 -
Glass-transition temperature ˚C		57-59	62	62	58	56

Source: Stereolithography Materials Technical Datasheets, Huntsman Advanced Materials, production3dprinters.com/materials/sla February 2015

Process	Vat photopolymerization				
Manufacturer	DSM Somos (1 of 4)				
Material	Somos ProtoGen 18120	Somos ProtoGen 18420	Somos ProtoGen 18920	Somos ProtoCast 19122	WaterClear Ultra 10122
Type of material	photopolymer liquid resin				
Type of laser (machine)	solid-state lasers				
Notes	general-purpose, high-temperature ABS-like parts, high accuracy, humidity and temperature resistant parts	general-purpose, high-temperature ABS-like parts, high accuracy, humidity and temperature resistant parts	general-purpose, humidity and temperature tolerant, ABS-like material	antimony-free, low ash residue for investment-casting applications	optically clear resin with ABS-like properties and improved water resistance (water absorption 0.8%), temperature resistant, low viscosity
Postcure method	UV light and heat			UV light	
Process properties – liquid resin					
Critical exposure E_c (mJ/cm^2)	6.73	6.73	7.0	11.5	10.0
Depth of penetration D_p (mils)	4.57	4.34	4.2	5.2	6.5
Viscosity centipoise at 30°C	300	350	350	100	165
Density g/cm^3 at 25°C	1.16	1.16	1.16	1.13	1.13

Continued on the following page

Material		Somos ProtoGen18120	Somos ProtoGen 18420	Somos ProtoGen 18920	Somos ProtoCast 19122	WaterClear Ultra 10122
Physical properties						
Tensile strength at break (ASTM D638) lb/in^2 (MPa)	**UV postcure**	7,500-8,000 (51.7-54.9)	6,100-6400 (42.2-43.8)	6,800-6,900 (46.6-47.8)	6,500- 6,600 (44.5-45.3)	7,900-8,100 (55-56)
	UV plus heat	9,900-10,000 (68.8-69.2)	9,600-9,900 (66.1-68.1)	10,000-10,100 (69.2-69.6)		
Tensile modulus (ASTM D638) lb/in^2 (MPa)	**UV postcure**	381,000-397,000 (2,620-2,740)	316,000-336,000 (2,180-2,310)	305,000-336,000 (2,103-2,317)	292,000-317,200 (2,013-2,187)	414,000-421,000 (2,860-2,900)
	UV plus heat	422,000-433,000 (2,910-2,990)	417,000-430,000 (2,880-2,960)	369,000-423,000 (2,544-2,916)		
Elongation (ASTM D638) % at break	**UV postcure**	6-12	8-16	13-19	6	6-9
	UV plus heat	7-8	6-9	4-9		
Impact strength (notched Izod) ft-lb/in of notch (J/m)	**UV postcure**	0.26-0.49 (14-26)	0.37-0.41 (20-22)	0.26-0.52 (18-28)	0.32-0.54 (17-29)	0.44-0.48 (24-26)
	UV plus heat	0.24-0.47 (13-25)	0.28-0.34 (15-18)	0.37-0.45 (20-24)		
Hardness (Shore D-scale)	**UV postcure**	84-85	86-88	85-86	84-86	86-87
	UV plus heat	87-88	86-87	86-88		
General information						
Heat deflection temperature °C @66 lb/in^2 @264 lb/in^2	**UV postcure**	55-58 48-50	53-56 46-47	58.7 51	59 50	46-47 42-43
	UV plus heat	95-97 79-82	93-98 74-78	96.5 78.6		
Glass-transition temperature °C		71-94	57-96	6.9-97.5	49	42-46

Source: Stereolithography Product Data Sheets, DSM Somos, http://www.dsm.com/products/somos/en_US/offerings.html, February 2015

Process	Vat photopolymerization				
Manufacturer	DSM Somos (2 of 4)				
Material	Somos BioClear	WaterShed XC 11122	Somos 9120	Somos 9110	Somos ProtoTherm 12110
Type of material	photopolymer liquid resin				
Type of laser (machine)	solid-state lasers			helium-cadmium lasers (SLA 190/SLA 250)	
Notes	clear, strong, tough and water resistant parts	strong, tough, water-resistant, ABS-like parts, high dimensional stability, nearly colorless	epoxy, durable resin for functional parts	epoxy, robust resin for functional parts, chemical resistance,	strong, high-temperature tolerant, water-resistant resin; parts have cherry-red appearance, high tensile strength
Postcure method	UV light				UV light and heat
Process properties — liquid resin					
Critical exposure E_c (mJ/cm^2)	11.5	11.5	10.9	8.0	12.2
Depth of penetration D_p (mils)	6.5	6.5	5.6	5.2	5.5
Viscosity centipoise at 30°C	260	260	450	230	410
Density g/cm^3 at 25°C	1.12	1.12	1.13	1.13	1.15

Continued on the following page

Material		Somos BioClear	WaterShed XC 11122	Somos 9120	Somos 9110	Somos ProtoTherm 12110
Physical properties						
Tensile strength (ASTM D638) lb/in^2 (MPa)	**UV postcure**	6,800-7,800 (47.1-53.6)	6,800-7,800 (47.1-53.6)	4,400-4,700 (30-32)	4,500 (31)	8,400 (57.6)
	UV plus heat					9,500 (65.5)
Tensile modulus (ASTM D638) lb/in^2 (MPa)	**UV postcure**	384,000-420,000 (2,650-2,880)	384,000-420,000 (2,650-2,880)	178,000-212,000 (1,227-1,462)	231,000 (1,590)	497,500 (3,430)
	UV plus heat					427,900 (2,950)
Elongation (ASTM D638) % at break	**UV postcure**	11-20	11-20	15-25	15-21	5
	UV plus heat					3.8
Impact strength (notched Izod) ft-lb/in of notch (J/m)	**UV postcure**	0.40-0.60 (20-30)	0.4-0.6 (20-30)	0.9-1.0 (48-53)	1.03 (55)	0.32 (12)
	UV plus heat					0.29 (21)
Hardness (Shore D-scale)	**UV postcure**	N/A	N/A	80-82	83	84.5
	UV plus heat					86.4
General information						
Heat deflection temperature °C @66 lb/in^2 @264 lb/in^2	**UV postcure**	45.9-54.5 49.0-49.7	45.9-54.5 49.0-49.7	52-61	50 -	52.9 48
Glass-transition temperature °C		39-46	39-46	N/A	N/A	59.4

Source: Stereolithography Product Data Sheets, DSM Somos, http://www.dsm.com/products/somos/en_US/offerings.html, February 2015

Process	Vat photopolymerization			
Manufacturer	DSM Somos (3 of 4)			
Material	Somos ProtoTherm 12120	Somos GP Plus 14122	Somos 9420	Somos PerFORM
Type of material	photopolymer liquid resin			
Type of laser (machine)	solid-state lasers			
Notes	strong, high-temperature tolerant, water-resistant resin; parts have cherry-red appearance	low viscosity liquid, water-resistant, durable and accurate three-dimensional parts, ABS like parts	superior fatigue properties, strong memory retention and high quality up-facing and down-facing surfaces	excellent detail resolution. Faster and easier processing. Ideal for tooling, high temperature testing, electrical castings and automotive housings
Postcure method	UV light and heat	UV light	UV light and heat	
Process properties — liquid resin				
Critical exposure E_c (mJ/cm^2)	11.8	13.0	15.0	7.8
Depth of penetration D_p (mils)	6.0	6.25	5.4	4.3
Viscosity centipoise at 30°C	550	340	475	1,000
Density g/cm^3 at 25°C	1.15	1.16	1.13	1.61

Continued on the following page

Material		Somos ProtoTherm 12120	Somos GP Plus 14122	Somos 9420	Somos PerFORM
Physical properties					
Tensile strength (ASTM D638) lb/in^2 (MPa)	**UV postcure**	10,200 (70.2)	4,900-5,800 (33.8-40.2)	2,500-2,900 (17-20)	9900 (68)
	UV plus heat	11,200 (77.0)			11800(80)
Tensile modulus (ASTM D638) lb/in^2 (MPa)	**UV postcure**	511,000 (3,520)	344,000-384,000 (2,370-2,650)	80,000-120,000 (553-850)	1,520,000 (10,500)
	UV plus heat	471,000 (3,250)			1,420,000 (9800)
Elongation (ASTM D638) % at break	**UV postcure**	4	6-9	25-30	1.1
	UV plus heat	4.5			1.2
Impact strength (notched Izod) ft-lb/in of notch (J/m)	**UV postcure**	0.22 (12.0)	0.43-0.54 (23-29)	0.82-0.9 (44-48)	0.32 (17)
	UV plus heat	0.32 (17.0)			0.37 (20)
Hardness (Shore D-scale)	**UV postcure**	85.3	79	70-74	94
	UV plus heat	86.7			93
General information					
Heat deflection temperature °C @66 lb/in^2 @264 lb/in^2	**UV postcure**	56.5 51.9	46 41	47-50 36-38	- 82
	UV plus heat	126.2 110.7			- 119
Glass-transition temperature °C	**UV postcure**	74-111	41-43	57-60	72
	UV plus heat				81

Source: Stereolithography Product Data Sheets, DSM Somos, http://www.dsm.com/products/somos/en_US/offerings.html, February 2015

Process	Vat photopolymerization				
Manufacturer	DSM Somos (4 of 4)				
Material	Somos 14120 White	Somos NanoForm 15120	Somos NanoTool	Somos NeXt	Somos NeXt LV Grey
Type of material	photopolymer liquid resin			composite-filled photopolymer resin	photopolymer liquid resin
Type of laser	solid-state lasers				
Notes	low-viscosity resin for strong, tough, water-resistant parts	nanoparticle-filled resin for strong, stiff, high-temperature-resistant parts with an opaque gray appearance	strong, stiff, high-temperature resistant composite parts	very resistant to breakage, ideal for low-volume manufacturing applications where toughness is required, moisture resistant, and very good thermal properties	creates tough ABS-like parts with a high modulus, maintains low viscosity, good water resistant and thermal properties, resistant to fracture
Postcure method	UV light		UV light	UV light and heat	UV light
Process properties – liquid resin					
Critical exposure E_c (mJ/cm^2)	13.0	16.3	8.3	12	14.6
Depth of penetration D_p (mils)	6.25	5.2	4.3	5.8	5.16
Viscosity centipoise at 30°C	240	570	2,500	1,000	480
Density g/cm^3 at 25°C	1.10	1.33 (liquid) 1.38 (solid)	1.65	1.17	1.12

Continued on the following page

Material		Somos 14120	Somos NanoForm 15120	Somos NanoTool	Somos NeXt	Somos NeXt LV Grey
Physical properties						
Tensile strength (ASTM D638) lb/in^2 (MPa)	**UV postcure**	6,600 (45.7)	6,900 (48)	8,900-11,300 (61.7-78)	343,000-361,000 (2,370-2,490)	8,700-9.600 (60-66)
	UV plus heat		7,700 (53)	9,600-11,600 (66.3-80.3)		
Tensile modulus (ASTM D638) lb/in^2 (MPa)	**UV postcure**	357,000 (2,460)	725,000 (5,000)	1,590,000-1,650,000 (11,000-11,400)	5,900-6,300 (41.1-43.3)	431,000-476,000 (2,970-3,285)
	UV plus heat		856,000 (5,900)	1,510,000-1,620,000 (10,400-11,200)		
Elongation (ASTM D638) % at break	**UV postcure**	8	2.1	0.7-1.0	8-10	4.6-7.2
	UV plus heat		1.2	0.7-1.0		
Impact strength (notched Izod) ft-lb/in of notch (J/m)	**UV postcure**	0.44 (23.5)	0.28 (15.0)	0.23-0.29 (12-15)	0.88-0.97 (47-52)	0.56-0.66 (30-35)
	UV plus heat		0.30 (15.9)	0.26-0.36 (14-16)		
Hardness (Shore D-scale)	**UV postcure**	81	93	94	82	84
	UV plus heat		92	94		
General information						
Heat deflection temperature °C @66 lb/in^2 @264 lb/in^2	**UV postcure**	53 48	65.5 52.9	225 85-90	55-57 48-51	53-57 49-57
	UV plus heat		269 115	258-263 104		
Glass-transition temperature °C	**UV postcure**	44	39	57-89	43-47	40-48
	UV plus heat		80	85-90		

Source: Stereolithography Product Data Sheets, DSM Somos, http://www.dsm.com/products/somos/en_US/offerings.html, February 2015

Process	Vat photopolymerization		
Manufacturer	Allied PhotoPolymers (1 of 1)		
Material	KZ-1860-CL	KZ-1870-WH	KZ-1862-ICE
Type of material	photopolymer liquid resin		
Type of laser (machine)	solid-state 355nm lasers		
Notes	ABS-like, dimensionally stable, humidity resistance, ideal for QuickCast applications	ABS-like, dimensionally stable, general purpose, humidity resistant	ABS-like resin and water-resistant for general-purpose
Postcure method	UV light		
Process properties – liquid resin			
Critical exposure E_c (mJ/cm^2)	11.2	10.4	11.2
Depth of penetration D_p (mils)	6.6	5.8	6.6
Viscosity centipoise at 30°C	270	500	270
Density g/cm^3 at 25°C	1.12	1.13	1.12
Physical properties			
Tensile strength (ASTM D638) lb/in^2 (MPa)	7,540 (52)	7,690 (53)	7,540 (52)
Tensile modulus (ASTM D638) lb/in^2 (MPa)	363,000 (2,500)	305,000 (2,100)	363,000 (2,500)
Elongation (ASTM D638) % at break	6-10	5-9	6-10
Impact strength (notched Izod) ft-lb/in of notch (J/m)	0.4 (21.4)	0.45 (24)	0.4 (21.4)
Hardness (Shore D-scale)	83	80	83
General information			
Heat deflection temperature °C @66 lb/in^2 @264 lb/in^2	55 50	50 45	55 50
Glass-transition temperature °C	N/A	N/A	N/A

Source: Material Data Sheets, Allied PhotoPolymers, http://alliedphotopolymers.com/absresins.html, February 2015

Process	Vat photopolymerization						
Manufacturer	Envisiontec (1 of 3)						
Material	NanoCure RC25	R05	R11	PIC 100 series	e-Shell 200	e-Shell 300	WIC100G Series
Type of material	nanoparticle-filled photopolymer	photopolymer	photopolymer	photopolymer	photo-reactive acrylate	photo-reactive acrylate	photopolymer
Type of machine	all Perfactory, Vanquish	all Perfactory, Standard, Vanquish	all Perfactory, Standard, Vanquish	all Perfactory, OTOFlash	all Perfactory, Vanquish	Perfactory UV machines only, ULTRA HR UV	all Perfactory products, OTOFlash
Notes	for strong, stiff, high-temperature resistant composite parts	for robust and accurate parts that are polypropylene-like	for robust and accurate parts that are polypropylene-like	for investment casting, the resin melts into liquid wax	Class IIa biocompatible photopolymer	Class IIa biocompatible photopolymer	nano wax content, allows for clean burnout for direct investment casting
Physical properties							
Tensile strength (ASTM D638) lb/in^2 (MPa)	6,600 (46)	4,496-5,656 (31-39)	7,252 (50.0)	2,437 (16.8)	8,383 (57.8)	7,484 (51.6)	2,146.6 (14.8)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	709,000 (4,890)	N/A	N/A	N/A	348,100 (2,400)	N/A	N/A
Elongation (ASTM D638) % at yield	2.5 (% at break)	16 (% at break)	13 (% at break)	7.46 (% at break)	6 (% at break)	6.62 (% at break)	6.3
Impact strength (notched Izod) of notch kJ/m2	0.016	0.27-0.50	0.35	11.03	2.1	4.99	N/A
Hardness (Shore D-scale)	93.1	N/A	N/A	69	83	85	80
General information							
Glass-transition temperature °C	70	37-52	N/A	N/A	109	86-160	300 (ignition temp)

Source: Technical Data Sheets, Envisiontec, http://envisiontec.com/materials/, February 2015

Process	Vat photopolymerization					
Manufacturer	Envisiontec (2 of 3)					
Material	eDent 100	Photosilver	WIC 300	e-shell 500	RC25	SI 500
Type of material	light cured micro-hybrid filled dental crown and bridge material	ceramic filled photopolymer	wax filled photopolymer	photo-reactive acrylate	nanoparticle filled material	photopolymer
Type of machine	Perfactory high productivity DDP, OTOFlash, PixCera, Perfactory DDSP	full range of Envisiontec machines	Envisiontec DDP	Perfactory UV machines only	all Perfactory standard	Perfactory products, 3D Bioplotter
Notes	for printing full dental crowns or multi-unit bridges	high temperature resistance and can produce high detail models for molding	good material stiffness, low thermal expansion, melts during burnout	photopolymer and soft material	used to build hard-wearing, stiff, and temperature resistant parts	high-temperature ABS-like photopolymer, high impact strength similar to thermoplastics
Physical properties						
Tensile strength (ASTM D638) lb/in^2 (MPa)	4,351 (30)	N/A	8,122 (56)	725 (5)	6,672 (46)	11,327 (78.1)
Elastic modulus (ASTM D638) lb/in^2(MPa)	638,166 (4,400)	N/A	485,876 (3,350)	N/A	709,234 (4,890)	388,700 (2,680)
Elongation (ASTM D638) % at yield	N/A	N/A	3.5	N/A	2.5 (at break)	4.4
Impact strength (notched Izod) of notch kJ/m2	N/A	N/A	N/A	N/A	0.016	0.061-0.071
Hardness (Shore D-scale)	25 HV	N/A	N/A	90 Shore A	93.1	85
General information						
Glass-transition temperature °C	N/A	N/A	N/A	N/A	42	61

Source: Technical Data Sheets, Envisiontec, http://envisiontec.com/materials/, February 2015

Process	Vat photopolymerization				
Manufacturer	Envisiontec (3 of 3)				
Material	LS600	E-Dentone	Clear Guide	E-Dent	E-Partial
Type of material	photopolymer	resin-based	crystal clear material	light-cured micro-hybrid filled dental crown and bridge material	N/A
Type of machine	Perfactory products	Perfactory 4 DDP (Original)	Perfactory 4 DDP (Original)	Micro DDP, PixCera, Perfactory 4 DDP	Perfactory 4 DDP
Notes	high-impact resistance similar to thermoplasstics	low viscosity formula	allows maximum visibility	structures can be cut back and then layered using any light-curable shade composite	very hard retention grid and super tight tin clasps to deliver a metal partial with the perfect fit
Physical properties					
Tensile strength (ASTM D638) lb/in^2 (MPa)	8,702 (60)	8,122 (56)	with D638 standard	with D638 standard	8,267 (57)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	261,068 (1,800)	N/A	with D638 standard	with D638 standard	N/A
Elongation (ASTM D638) % at yield	4.39 (at break)	3.5 (at break)	with D638 standard	N/A	3.6 (at break)
Impact strength (notched Izod) of notch kJ/m2	N/A	N/A	with D638 standard	N/A	N/A
Hardness (Shore D-scale)	85	N/A	85	N/A	89
General information					
Glass-transition temperature °C	N/A	N/A	N/A	N/A	N/A

Source: Technical Data Sheets, Envisiontec, http://envisiontec.com/materials/, February 2015

Process	Plastic powder bed fusion				
Manufacturer	3D Systems (1 of 2)				
Material	DuraForm PA	DuraForm GF	CastForm PS	DuraForm Flex	DuraForm EX
Type of material	polyamide powder (nylon)	glass-filled polyamide powder	polystyrene powder	elastomeric plastic powder	impact-resistant plastic
Type of machine	for use with all selective laser sintering systems; Sinterstation and Vanguard laser sintering systems available from 3D Systems				Sinterstation Pro and Sinterstation HiQ
Notes	good thermal stability and chemical resistance, for real world testing and functional use	high-durability material; good thermal stability and chemical resistance	directly produce investment cast patterns without tooling, performs almost identically to foundry wax for shell investment casting	rubber-like performance to simulate gaskets, hoses, seals; can be colored or pressure-sealed with infiltrants, good tear resistance and burst strength	toughness of injection-molded polypropylene and ABS plastic
General properties					
Density (g/cm^3)	0.59	1.49	0.46	0.44	N/A
Average particle size (microns)	58	48	62	85	N/A
Specific gravity at 20°C ($g/cm^{3)}$	1.00	1.49	0.86	N/A	1.01
Physical properties					
Tensile strength (ASTM D638) lb/in^2 (MPa)	6,237 (43)	3,771 (26)	412 (2.84)	262 (1.8) as produced 335 (2.3) infiltrated	6,961 (48)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	230,000 (1,586)	590,000 (4,068)	232,000 (1,604)	1,080 (7.4) as produced 1,340 (9.2) infiltrated	220,000 (1,517)
Elongation (ASTM D638) % at break	14	1.4	N/A	110 (as produced) 151 (infiltrated)	47
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	0.6 (32)	0.8 (41)	<0.21 (<11)	not available	1.4 (74)
Hardness (Shore D-scale)	73	77	N/A	55-80 Shore A @ 23° C	74
General information					
Melting point °C	N/A	N/A	>63	192	N/A
Glass-transition temperature °C	N/A	N/A	89	N/A	

Source: Laser Sintering Materials Datasheets, 3D Systems, http://www.3dsystems.com/materials/production, February 2015

Process	Plastic powder bed fusion					
Manufacturer	3D Systems (2 of 2)				Exceltec	
Material	DuraForm HST	DuraForm FR 100	CastFormPS	DuraForm EX Black	Innov'PA 1550_Xs	Innov'PA 2550_GBAL
Type of material	composite	halogen-free flame retardant plastic	styrene-based	impact-resistant plastic	polyamide powder (fine composite)	
Type of machine	all Sinterstation Pro and Sinterstation HiQ series SLS Systems				for use with all laser sintering systems	
Notes	functional prototypes, parts requiring high stiffness and/or elevated thermal resistance; high specific stiffness, elevated temperature resistance; anisotropic mechanical properties, non-conductive, RF transparent, easy-to-finish surface	meets flame retardancy necessary to for aerospace applications, reduces production of smoke and toxic byproducts of combustion (complies and meets UL94V-0)	creates complex patterns without welds or joints; compatible with autoclaves, low-temperature furnaces, and vacuum plaster casting methods	parts have the toughness of injection molded ABS and polypropylene	gives final production in natural color, can be colored with colored charge, exploitable on any type of system of prototyping	chemical resistance, good cohesion of layers, excellent resolution of contour and surface
General properties						
Density (g/cm^3)	N/A	1.03	0.46	N/A	0.98 ± 0.05	1.05 ± 0.05
Average particle size (microns)	N/A	N/A	N/A	N/A	38-48	35-65
Specific gravity at 20°C (g/cm^3)	1.20	1.07	0.86	1.01	N/A	N/A

Continued on the following page

Material	DuraForm HST	DuraForm FR 100	CastFormPS	DuraFormEX Black	Innov'PA 1550_Xs	Innov'PA 2550_GBAL
Physical properties						
Tensile strength (ASTM D638) lb/in^2 (MPa)	7,050-7,350 (48-51)	4,600 (32)	412 (2.84)	6,961 (48)	6,381 ± 145 (44 ± 1)	4,312 ± 145 (30 ± 1)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	795,000-831,000 (5,475-5,725)	273,000 (1,880)	232,000 (1,604)	220,000 (1,517)	224,200 ± 21,700 (1,550 ± 150)	369,000 ± 21,700 (2,550 ± 150)
Elongation (ASTM D638) % at break	4.5	20	N/A	47	15 ± 2	8 ± 1
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	0.7 (37.4)	0.92 (49)	<0.21 (<11)	1.4 (74)	80 KJ/m²	5 KJ/m²
Hardness (Shore D-scale)	75	73	N/A	74	68 ± 3	77 ± 2
General information						
Melting point °C	N/A	N/A	N/A	N/A	181-185	181-185
Glass-transition temperature °C	N/A	N/A	N/A	N/A	34 ± 2	N/A

Source: Laser Sintering Materials Datasheets, 3D Systems, http://www.3dsystems.com/materials/production, February 2015 and Exceltec Products, http://www.exceltec.eu/fr/products/pa12.html

Process	Plastic powder bed fusion			
Manufacturer	Arkema			
Material	Orgasol Ultrafine Polyamide	Rilsan Invent Natural	Rilsan Invent Black	Orgasol Invent Smooth
Type of material	Polyamide powder	Natural Polymide 11 powder	Mass- coloured polymide 11 powder	Natural polymide 12 powder
Type of machine	for use with all laser sintering systems			
Notes	high abrasion and scratch resistance, flexibility, gloss control and mar resistance,	chemical resistance, high UV resistance, low water re-uptake and low density	chemical resistance, high UV resistance, low water re-uptake and low density	chemical resistance, high UV resistance, low water re-uptake and low density
General properties				
Density (g/cm^3)	N/A	0.62 (bulk)	0.66 (bulk)	0.55 (bulk)
Average particle size (microns)	between 5 and 60	N/A	N/A	N/A
Specific gravity at 20°C (g/cm^3)	N/A	N/A	N/A	N/A
Physical properties				
Tensile strength (ASTM D638) lb/in^2 (MPa)	N/A	6,527 (45)	6,527 (45)	6,527 (45)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	N/A	217,557 (1,500)	217,557 (1,500)	261,067 (1,800)
Elongation (ASTM D638) % at break	N/A	45	45	20
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	N/A	N/A	N/A	N/A
Hardness (Shore D-scale)	N/A	77	77	76
General information				
Melting point °C	N/A	201	201	183
Glass-transition temperature °C	N/A	N/A	N/A	N/A

Source: Datasheets requested from Arkema at http://www.arkema.com/en/products/product-finder/index.html

Process	Plastic powder bed fusion				
Manufacturer	CRP Technology				
Material	Windform GF 2.0	Windform XT 2.0	Windform LX 2.0	Windform GT	Windform SP
Type of material	aluminum- and glass-filled nylon powder	carbon and nylon composite powder	polyamide-based material	polyamide-based material with fiber glass	polyamide-based material carbon filled
Type of machine	laser-sintering machines				
Notes	superior stiffness and surface finish	very high UTS and wear resistance	high elasticity, high melting point, durable, wear resistant	optimal charateristics of elasticity and ductility, damage resistance, very light material	resistance to damage,vibration and deformation, waterproof properties, optimal mechanical properties
General properties					
Density (g/cm^3)	1.41	1.097	1.311	1.19	1.106
Physical properties					
Tensile strength (ASTM D638) lb/in^2 (MPa)	7,339 (50.6) EN ISO 527-1-2	11,300 (83.84) EN ISO 527-1-2	8,700 (59.9) EN ISO 527-1-2	8,150 (56.21) EN ISO 527-1-2	11,000 (76.10) EN ISO 527-1-2
Tensile modulus (ASTM D638) lb/in^2 (MPa)	624,242 (4304) EN ISO 527-1-2	1,294,897 (8,928) EN ISO 527-1-2	906,100 (6,248) EN ISO 527-1-2	477,000 (3,289.80)	902,000 (6,219.6)
Elongation (ASTM D638) % at break	4.6	3.8	2.3	14.82	11.38
Impact strength (Charpy unnotched ASTM D256) ft-lb/in of notch (kJ/m^2)	21.85	22.43 EN ISO 179;2000	18.14	(8.69)	(28.86)
Hardness (Shore D-scale)	N/A	N/A	N/A	N/A	N/A
General information					
Melting point, °C	180	179.3	180	193	193.3

Source: Technical Sheets, CRP Technology, http://www.crptechnology.eu/windform-3d-printing-materials/, February 2015

Process	Plastic powder bed fusion					
Manufacturer	EOS (1 of 3)					
Material	PrimePart Plus PA 2221	EOS PEEK HP3	PA2210 FR	PA 2201	PA 2202 black	CarbonMide
Type of material	polyamide powder	thermoplastic from the polyaryletherketone (PAEK) group powder	polyamide powder with added chemical fire retardant	polyamide powder	polyamide powder	carbon fiber-filled polyamide powder
Type of machine	EOSINT P 730, 700, 390, 385, 380i, 380, 360, 350/2, FORMIGA P 100	EOSINT P 800, P 760, P 800	EOSINT P3 and P700 series, FORMIGA P 100	EOSINT P 730, 700, 390, 385, 380i, 380, 360, 350/2, FORMIGA P 100, P 110	EOSINT P 380i, 385 with PSW 3.2	EOSINT P38x, P 395
Notes	balance between mechanical strength and elasticity over a wide temperature range	semi-crystalline, thermoplastic material; excellent high temp performance, high wear resistance, chemical resistance, best smoke, fire, and toxicity performance, good hydrolysis performance, biocompatibility, sterility	for flame-resistant plastic parts	for fully functional parts with high-end finish directly from the process, withstand high mechanical and thermal load	for fully functional parts with high-end finish directly from the process, withstand high mechanical and thermal load	high stiffness and strength applications
General properties						
Density (g/cm^3)	0.93 (laser sintered)	1.31	1.06 (laser sintered)	0.93	0.98 (laser sintered)	1.04

Continued on the following page

Material	PrimePart Plus PA 2221	EOS PEEK HP3	PA2210 FR	PA 2201	PA 2202 black	CarbonMide
Physical properties						
Tensile strength (ISO 527-1/-2) lb/in^2 (MPa)	6,800 (47)	13,053 (90)	6,527 (45)	6,962 (48)	7,250 ± 290 (50 ± 2)	in *x*: 10,000 (72) in *y*: 8,000 (56) in *z*: 3,600 (25)
Tensile modulus (ISO 527-1/-2) lb/in^2 (MPa)	240,000 (1,650)	616,410 (4,250)	362,594 (2,500)	246,564 (1,700)	26,068±7,252 (1,800±50)	in *x*: 884,730 (6,100) in *y*: 493,128 (3,400) in *z*: 319,083 (2,200)
Elongation (ISO 527-1/-2) % at yield	16	2.8	5.0	15	12 ± 2	in *x*: 4.1, *y*: 6.3, *z*: 1.3 (at break)
Impact strength (notched test is 179/1eU) of notch (kJ/m²)	3.9	N/A	N/A	4.4	N/A	in *x*: 2.5 (5.3) *y*: 2.1 (4.4) *z*: 1.0 (2.1) (notched Charpy)
Hardness (Shore D-scale)	75	N/A	N/A	75	75	N/A
General information						
Melting point °C	176	372	185	176	176	176

Source: Material Data Sheets, EOS, http://www.eos.info/material-p,, February 2015

Process	Plastic powder bed fusion						
Manufacturer	EOS (2 of 3)						
Material	PA 2200 Balanced	PA 3200 GF	PrimeCast 101	Alumide	PA 1101	PA 1102 Black	PrimePart ST PEBA 2301
Type of material	polyamide powder	glass-filled polyamide powder	polystyrene powder	30% aluminum-filled polyamide	polyamide powder	polyamide powder	Polyether amide
Type of machine	EOSINT P 730, 700, 390, 385, 380i, 380, 360, 350/2, FORMIGA P 100, P 110		EOSINT P 350, 360, 380, 385,390,700, FORMIGA P 110	EOSINT P and FORMIGA systems	EOSINT P 730, 700, 390, 385, 380i, 380, 360, 350/2, FORMIGA P 100	EOSINT P 730, 700, 390, 385, 380i, 380, 360, 350/2, FORMIGA P 100	EOSINT P 395 (basic), EOSINT P 395 (surface)
Notes	good thermal stability and chemical resistance	high-durability material; good thermal stability and chemical resistance	suitable for building investment-casting patterns	stiff, durable parts with metallic grey appearance	extreme elasticity, high impact resistance, outstanding long term constancy, chemical resistance	extreme elasticity, high impact resistance, outstanding long term constancy, chemical resistance	high elasticity and strength good chemical resistance, excellent long term stability
General properties							
Density (g/cm^3) (laser sintered)	0.93	1.22	0.77	1.36	0.99	0.99	0.95

Continued on the following page

Material	PA 2200 Balanced	PA 3200 GF	PrimeCast 101	Alumide	PA 1101	PA 1102 Black	PrimePart ST PEBA 2301
Physical properties							
Tensile strength (ISO 527-1/-2) lb/in^2 (MPa)	6,960 (48)	7,340 (51)	800 (5.5)	6,960 (48)	6,960 (48)	6,960 (48)	1,160 (8)
Tensile modulus (ISO 527-1/-2) lb/in^2 (MPa)	244,000 (1,650)	464,000 (3,200)	232,000 (1,600)	551,000 (3,800)	218,000 (1500)	226,000 (1560)	10,900 (75)
Elongation (ISO 527-1/-2) % at yield	18 (at break)	9 (at break)	0.4 (at break)	4 (at break)	30	N/A	N/A
Impact strength (notched test is 179/1eU)of notch (kJ/m²)	4.8	5.4	N/A	2.19 lbf/in^2 (4.6 kJ/m^2) (Charpy scale)	N/A	7.8	N/A
Hardness (Shore D-scale)	75	80	N/A	76	77	N/A	35
General information							
Melting point °C	176	176	N/A	176	201	201	302
Glass-transition temperature °C	N/A	N/A	105	N/A	N/A	N/A	N/A

Source: Material Data Sheets, EOS, http://www.eos.info/material-p, February 2015

Process	Plastic powder bed fusion					
Manufacturer	EOS (3 of 3)					
Material	PA 2105	PA 2200 Performance 1.0	PA 2200 Speed 1.0	PA Top 2200 Quality 1.0	PA 2200 Top Speed 1.0	PA 2241
Type of material	Polyamide 12 powder					
Notes	colored by light skin color pigments	high strength and stiffness, good chemical resistance, high selectivity and detail resolution	high strength and stiffness, good chemical resistance, high selectivity and detail resolution	high strength and stiffness, good chemical resistance, high selectivity and detail resolution	high strength and stiffness, good chemical resistance, high selectivity and detail resolution	high strength and stiffness, good chemical resistance, high selectivity and detail resolution
General properties						
Density (g/cm^3) (laser sintered)	0.95	0.93	0.93	0.93	0.93	0.93
Physical properties						
Tensile strength (ISO 527-1/-2) lb/in^2 (MPa)	7,832 (54)	7,252 (50)	6,961 (48)	7,250 (50)	6,960 (48)	6,672 (46)
Tensile modulus (ISO 527-1/-2) lb/in^2 (MPa)	268,320 (1,850)	246,564 (1700)	232,000 (1,600)	261,000 (1,800)	217,557 (1,500)	362,594 (2,500)
Elongation (ISO 527-1/-2) % at yield	20 (at break)	20 (at break)	18 (at break)	20 (at break)	18 (at break)	N/A
Impact strength (notched testis 179/1eU)of notch (kJ/m^2)	N/A	4.8	4.8	4.8	4.8	N/A
Hardness (Shore D-scale)	75	75	75	75	75	N/A
General information						
Melting point °C	176	176	176	176	176	185
Glass-transition temperature °C	N/A	N/A	N/A	N/A	N/A	N/A

Source: Material Data Sheets, EOS, http://eos.materialdatacenter.com/eo/, February 2015

Process	Metal powder bed fusion		
Manufacturer	EOS (1 of 2)		
Material	EOS StainlessSteel GP1	EOS StainlessSteel PH1	MaragingSteel MS1 (based on provisional product data sheet)
Type of material	fine-grained, pre-alloyed stainless steel powder; alloying elements: Cr, Ni, Cu, Mn, Si, Mo, Nb, C	fine-grained, stainless steel powder including alloy elements Fe, Cr, Ni, Cu, Mn, Si, Mo, Nb, C	pre-alloyed, ultra-high-strength steel powder, containing Fe, Ni, Co, Mo, Ti, Al, Cr, C, Mn, Si, P, S
Type of machine	EOSINT M Systems, specially optimized for the EOSINT M 270, M 280	EOSINT M Systems, specially optimized for the EOSINT M 270, M 280	EOSINT M 270, M 280
Notes	functional prototypes, small series production, individualized products etc. with high toughness and ductility	functional prototypes, small series production, individualized products etc. with high toughness and ductility	tooling, parts requiring particularly high strength and hardness
General properties			
Density (g/cm^3)	part density with standard parameters: 7.8	part density with standard parameters: .8	part density with standard parameters: 8.0-8.1
Average particle size (microns)	approx. 20	approx. 20	approx.20
Physical properties			
Tensile strength (ASTM D638) lb/in^2 (MPa)	in *x-y*: 152,290 (1,050 ± 50) in *z*: 142,137 (980 ± 50)	in *x-y*: 166,793 (1,150 ± 50) in *z*: 152,290 (1050 ± 50)	after age hardening: 159,541 up to 282,823 (1,100 up to 1,950)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	24,656,420 (170,000 ± 20,000)	26,000,000 (180,000)	26,000,000 (180,000 ± 20,000)
Elongation (ASTM D638) % at yield	25 ± 5	in *x-y*: 16 ± 4 in *z*: 17 ± 4	8 ± 3 (at break)
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	N/A		
Hardness (Shore D-scale)	approx. 230 ± 20 Vickers Scale	30-35 Rockwell C-scale	33-37 as built; up to 50-54 on Rockwell C after age hardening

Source: Material Data Sheets, EOS, February 2015

Process	Metal powder bed fusion				
Manufacturer	EOS (2 of 2)				
Material	EOS CobaltChrome MP1	EOS CobaltChrome SP2	EOS Titanium Ti64	EOS NickelAlloy IN718	EOS Aluminum
Type of material	fine-grained CoCrMo-based superalloy powder; contains Co, Cr, Mo, Si, Mn, Fe, C, Ni	fine-grained Co, Cr, Mo, and W (cobalt-chrome-molybdenum) based alloy powder; contains Co, Cr, Mo, W, Si, Fe, Mn	fine-grained pre-alloyed Ti-Al6-V4 alloy powder	nickel alloy powder	aluminum alloy fine powder
Type of machine	EOSINT M 270, M 280		EOSINT M 270 (titanium version)	EOSINT M 270, M 280	EOSINT M270, M 280
Notes	especially suitable for biomedical implants and parts requiring high mechanical properties in elevated temperatures	composition corresponds for type 4 CoCr dental material standard, fulfills the chemical and thermal requirements of porcelain-fused metal of dental materials and the requirements for biocompatibility and cytoxity of dental materials	good mechanical properties, corrosion resistance, low specific weight, bio-compatibility, especially suitable for biomedical implants and parts requiring high strength to weight ratio including aerospace and motorsports	heat-resistant nickel alloy powder, ideal for high temperature application, good cryogenic properties and potential for cryogenic application	good casting properties typically used for cast parts with thin walls and complex geometries; good strength and hardness, low weight with good thermal properties
General properties					
Density (g/cm^3)	with standard parameters: 8.3	with standard parameters: 8.6	with standard parameters: 4.43	with standard parameters: 8.4	2.68
Average particle size (microns)	approx. 20	approx. 20	approx. 30	approx. 20	N/A

Continued on the following page

Material	EOS CobaltChrome MP1	EOS CobaltChrome SP2	EOS Titanium Ti64	EOS NickelAlloy IN718	EOS Aluminium
Physical properties					
Tensile strength (ASTM D638) lb/in^2 (MPa)	in *x-y*: 174,045 (1,200 ±150) in *z*: 174,045 (1,200 ± 150)	195,801 (1,350 ± 100)	166,793 (1,150 ± 60)	in *x-y*: 144,000 ± 7,000 (990 ± 50) in *z*: 131,000 ± 7,000 (900 ± 50)	in *x-y*: 64,500 ± 2,900 (445 ± 20) in *z*: 58,700 ± 2,900 (405 ± 20)
Elastic modulus (ASTM D638) lb/in^2 (MPa)	27,557,000 (190,000 ± 20,000)	24,656,000 (170,000 ± 20,000)	15,954,000 (110,000 ± 7,000)	in *x-y*: 25,000,00 ± 3,000,000 (170,000 ± 20) in *z*: 20,000,000 ± 3,000,000 (140,000 ± 20,000)	in *x-y*: 10,200,000 ± 700,000 (70,000 ± 5,000) in *z*: 33,400 ± 1,500 (230 ± 10)
Elongation (ASTM D638) % at yield	in *x-y*: 8 in *z*: 8	6-8	5 ± 3	in *x-y*: 35 ± 5 in z: 42 ± 5	in *x-y*: 6.5 ± 2 in *z*: 3.5 ± 2
Impact strength (notched Izod test) ft-lb/in of notch (J/m)	N/A	N/A	N/A	N/A	N/A
Hardness (Shore D-scale)	35-45 Rockwell C-scale	350-450 HV10	41-44 Rockwell C-scale	approx. 30 Rockwell C-scale	120±5
General information					
Melting point °C	1,350-1,430º	1,420-1,450º	N/A	N/A	N/A
Glass-transition temperature °C	N/A				

Source: Material Data Sheets, EOS, http://www.eos.info/material-m, February 2015

Process	Metal powder bed fusion			
Manufacturer	Arcam (1 of 1)			
Material	Ti6Al4V titanium alloy	Ti6Al4V ELI titanium	Grade 2 titanium	ASTM F75 CoCr alloy
Type of material	titanium alloy powder	titanium alloy powder	unalloyed commercially pure (CP) titanium powder	cobalt-based alloy powder
Type of machine	Arcam A2, EBM S12, Arcam Q10 and Q20	Arcam A2, EBM S12, Arcam Q10 and Q20	Arcam A2, EBM S12, Arcam Q10 and Q20	Arcam A2, EBM S12, Arcam Q10 and Q20
Notes	Grade 5, the most widely used titanium alloy, corrosion resistant, good machinability, good weight reduction applications, excellent biocompatibility, especially when direct contact to bone or tissue is required; contains Al, V, C, Fe, O, N, H, and Ti	a widely used titanium alloy, corrosion resistant, good machinability, good weight reduction applications, excellent biocompatibility, especially when direct contact to bone or tissue is required; contains Al, V, C, Fe, O, N, H, and Ti, Grade 23: similar to Ti6Al4V, but contains reduced levels of oxygen, nitrogen, carbon, and iron--for "extra low interstitials"	Grade 2, good corrosion resistance, formability, and weldable characteristics; stronger than Grade 1 and equally corrosion-resistant in most applications; good biocompatibility especially when in direct contact with tissue or bone is required; contains levels of C, Fe, O, N, H, and Ti	widely used for medical implant applications especially where high stiffness, highly polished, and extremely wear-resistant material is required; non-magnetic CoCrMo alloy with high strength, corrosion resistance, and good wear resistance; contains levels of Cr, Mo, Ni, Fe, C, Si, Mn, W, P, S, N, Si, Ti, B, Co
General properties				
Density (g/cm^3)	N/A			
Average particle size (microns)	45-100	45-100	45-100	45-100
Specific gravity at 20°C	N/A			
Physical properties				
Ultimate tensile strength (Rm) lb/in^2 (MPa)	147,940 (1,020)	140,690 (970)	82,670 (570)	140,000 (960)*
Yield strength (Rp 0.2) lb/in^2 (MPa)	137,790 (950)	134,890 (930)	78,320 (540)	80,000 (560)*
Elongation (ASTM D638) % at yield	14	16	21	20*
Reduction of area	40%	50%	55%	20%*
Hardness (Rockwell C-scale)	33	32	N/A	34*
Fatigue strength @ 600 MPa	>10,000,000 cycles	>10,000,000 cycles	N/A	>10,000,000 cycles (at 610 MPa)
Modulus of elasticity (GPa)	120	120	N/A	N/A

Source: Material Data Sheets, Arcam, http://www.arcam.com/technology/products/metal-powders/, February 2015
* Data collected after parts underwent heat treatment.

Process	Metal powder bed fusion		
Manufacturer	SLM Solutions (1 of 4)		
Material	TiAl6V4	TiAl6Nb7	Reintitan
Type of material	titanium alloy powder		
Type of machine	SLM 125, SLM 280, and SLM 500		
Notes	layer thickness 30 microns; without heat treatment		
General properties			
Density (g/cm^3)	N/A		
Average particle size (microns)	30	30	30
Specific gravity at 20°C	N/A		
Physical properties			
Ultimate tensile strength (Rm) lb/in^2 (MPa)	186519 (1286)	140977 (972)	42060 (290)
Yield strength (Rp 0.2) lb/in^2 (MPa)	161862 (1116)	125457 (865)	26106 (180)
Elongation (ASTM D638) % at yield	8	10	20
Reduction of area	30	N/A	
Hardness (Vickers – HV10)	384	360	130-210
Fatigue strength @ 600 MPa	N/A		
Modulus of elasticity (GPa)	111	N/A	105

Source: http://www.stage.slm-solutions.com/download.php?f=0c4e94b4e06f805e65f3698bf1ff391e , February 2015

Process	Metal powder bed fusion			
Manufacturer	SLM Solutions (2 of 4)			
Material	1.4340(15-5PH)	1.4404(316L)	1.2344(H13)	1.2709
Type of material	stainless steel and tool steel powder			
Type of machine	SLM 125, SLM 280, SLM 500			
Notes	great hardness, good durability, corrosion resistance, plastic injection and pressure die casting moulds, maritime, automotive			
General properties				
Density (g/cm^3)	N/A			
Average particle size (microns)	30			
Specific gravity at 20°C	N/A			
Physical properties				
Ultimate tensile strength (Rm) lb/in^2 (MPa)	159541 (1100)	94854 (654)	250915 (1730)	147213 (1015)
Yield strength (Rp 0.2) lb/in^2 (MPa)	148663 (1025)	79770 (550)	N/A	12386216 (854)
Elongation (ASTM D638) % at yield	16	35	N/A	10
Reduction of area	N/A	59		26
Hardness (Vickers – HV10)	N/A	233	N/A	310
Fatigue strength @ 600 MPa	N/A			
Modulus of elasticity (GPa)	N/A	169	N/A	142

Source: http://www.stage.slm-solutions.com/download.php?f=0c4e94b4e06f805e65f3698bf1ff391e , February 2015

Process	Metal powder bed fusion			
Manufacturer	SLM Solutions (3 of 4)			
Material	AlSi12	AlSi10Mg	AlSi7Mg	CoCr1 (F75)
Type of material	aluminum alloy powder			cobalt-chromium alloy powder
Type of machine	SLM 125, SLM 280, and SLM 500			
Notes	low density, good alloying properties, good processability (casting and pressing etc.); good electrical conductivity			high toughness, high strength, biocompatibility, corrosion resistance
General properties				
Density (g/cm^3)	N/A			
Average particle size (microns)	30			
Specific gravity at 20°C	N/A			
Physical properties				
Ultimate tensile strength (Rm) lb/in^2 (MPa)	59320 (409)	57579 (397)	42641 (294)	(1050)
Yield strength (Rp 0.2) lb/in^2 (MPa)	30602 (211)	32923 (227)	21320 (147)	121106 (835)
Elongation (ASTM D638) % at yield	5	6	3.3	N/A
Reduction of area	N/A	8	N/A	N/A
Hardness (Vickers – HV10)	110	117	105	345
Fatigue strength @ 600 MPa	N/A			
Modulus of elasticity (GPa)	N/A	64	N/A	N/A

Source: http://www.stage.slm-solutions.com/download.php?f=0c4e94b4e06f805e65f3698bf1ff391e , February 2015

Process	Metal powder bed fusion			
Manufacturer	SLM Solutions (4 of 4)			
Material	Hastelloy X	Inconel 625	Inconel 718	Inconel 939
Type of material	nickel-based alloy powder			
Type of machine	SLM 125, SLM 280, and SLM 500			
Notes	corrosion resistance, excellent mechanical strength up to 700°C, good weldability			
General properties				
Density (g/cm^3)	N/A			
Average particle size (microns)	30			
Specific gravity at 20°C	N/A			
Physical properties				
Ultimate tensile strength (Rm) lb/in^2 (MPa)	111969 (772)	139381 (961)	144312 (995)	146343 (1009)
Yield strength (Rp 0.2) lb/in^2 (MPa)	86297 (595)	102541 (707)	99930 (689)	106602 (735)
Elongation (ASTM D638) % at yield	20	33	29	30
Reduction of area	21	51	47	45
Hardness (Vickers – HV10)	248	285	306	302
Fatigue strength @ 600 MPa	N/A			
Modulus of elasticity (GPa)	162	182	173	177

Source: http://www.stage.slm-solutions.com/download.php?f=0c4e94b4e06f805e65f3698bf1ff391e, February 2015

Process	Metal powder bed fusion					
Manufacturer	Renishaw (1 of 2)					
Material	cp-titanium	Ti Al6Nb7	Ti Al6V4	Al Si12	Al Si10 Mg	CoCr ASTM F75
Type of material	pure titanium powder	titanium alloy powder	titanium alloy powder	aluminum alloy powder	aluminum alloy powder	cobalt-chrome alloy powder
Type of machine	SLM systems	SLM systems	SLM systems	SLM systems	SLM systems	SLM systems
Notes	high strength, low weight, high corrosion resistance, good biocompatibility, low thermal expansion, good machinability	high strength, low weight, high corrosion resistance, good biocompatibility, low thermal expansion, good machinability	high strength, low weight, high corrosion resistance, good biocompatibility, low thermal expansion, good machinability	low density, good alloying properties, good processability (casting and pressing, etc.), good electrical conductivity	low density, good alloying properties, good processability (casting and pressing, etc.), good electrical conductivity	high toughness, high strength, good biocompatibility, good corrosion resistance
Physical properties						
Tensile strength R_m (MPa)	>290	1,185 (±30)	1,091 (±30)	330 (±20)	N/A	1,050 (±20)
Offset yield stress $R_{p0,2}$ (MPa)	>180	1,100 (±30)	1,013 (±40)	194 (±20)	N/A	835 (±20)
Hardness Rockwell C Scale	>120	39.4 (±2)	37.3 (±2)	105 HB (±1)	N/A	35 (±1)
Bar impact value (J)	>20	11-18	10-18	6.8	N/A	11-14
Surface roughness R_z *x-y* (microns)	14 (±2)	14 (±2)	14 (±2)	15 (±2)	N/A	17 (±2)
Surface roughness R_z *z* (microns)	36 (±4)	36 (±4)	36 (±4)	34 (±4)	N/A	29 (±4)
Thermal conductivity at 20°C (W/mK)	22.6	7	7.1	N/A	N/A	N/A

Source: Material Data Sheets, Renishaw, http://www.renishaw.com/en/data-sheets--17862#ElementMediaList41972, February 2015

Process	Metal powder bed fusion					
Manufacturer	Renishaw (2 of 2)					
Material	1.4404 (316L)	1.2344 (H13)	1.4410	1.2709	1.4542 (17-4PH)	M333
Type of material	tool steel/ stainless steel	tool steel/ stainless steel	tool steel/ stainless steel	tool steel/ stainless steel	tool steel/ stainless steel	tool steel/ stainless steel
Type of machine	SLM systems	SLM systems	SLM systems	SLM systems	SLM systems	SLM systems
Notes	high hardness and toughness, high corrosion resistance, good machinability; can be used in plastic injection and pressure die-casting molds, medical implants, cutlery and kitchenware, maritime, spindles and screws	high hardness and toughness, high corrosion resistance, good machinability; can be used in plastic injection and pressure die-casting molds, medical implants, cutlery and kitchenware, maritime, spindles and screws	high hardness and toughness, high corrosion resistance, good machinability; can be used in plastic injection and pressure die-casting molds, medical implants, cutlery and kitchenware, maritime, spindles and screws	high hardness and toughness, high corrosion resistance, good machinability; can be used in plastic injection and pressure die-casting molds, medical implants, cutlery and kitchenware, maritime, spindles and screws	high hardness and toughness, high corrosion resistance, good machinability; can be used in plastic injection and pressure die-casting molds, medical implants, cutlery and kitchenware, maritime, spindles and screws	high hardness and toughness, high corrosion resistance, good machinability; can be used in plastic injection and pressure die-casting molds, medical implants, cutlery and kitchenware, maritime, spindles and screws
Physical properties						
Tensile strength R_m (MPa)	625 (±30)	1,730 (±30)	750 (±20)	N/A	N/A	N/A
Offset yield stress $R_{p0,2}$ (MPa)	525 (±30)	N/A	540 (±20)	N/A	N/A	N/A
Hardness Rockwell C Scale	237 (±4) HV	54 (±2) HRC	272 (±4) HV	N/A	N/A	N/A
Bar impact value (J)	75 (±4)	N/A	90 (±4)	N/A	N/A	N/A
Surface roughness R_z *x-y* (microns)	16 (±2)	13 (±2)	16 (±2)	N/A	N/A	N/A
Surface roughness R_z *z* (microns)	38 (±4)	34 (±4)	38 (±4)	N/A	N/A	N/A
Thermal conductivity at 20°C (W/mK)	15	25.6	15	N/A	N/A	N/A

Source: Material Data Sheets, Renishaw, http://www.renishaw.com/en/data-sheets--17862#ElementMediaList41972, February 2015

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