

# Direct Metal Printers

Metal Additive Manufacturing with the ProX® DMP 3D printers



ProX DMP 100



ProX DMP 200



ProX DMP 300



ProX DMP 320

| Specifications  |   |  |  |  |
|---|---|--|--|--|
| Laser Power Type  | 50 W/Fiber laser  | 300 W/Fiber laser  | 500 W/Fiber laser  | 500 W/Fiber laser  |
| Laser Wavelength  | 1070 nm   | 1070 nm  | 1070 nm  | 1070 nm  |
| Layer Thickness Range Preset                            | Adjustable, min 10 µm, no max                                   |  |  | Adjustable, min 2 µm, no max 30 and 60 µm  |
| Build Envelope Capacity (X x Y x Z)                     | 3.94 x 3.94 x 3.94 in (100 x 100 x 100 mm) <sup>1</sup>         | 5.51 x 5.51 x 4.92 in (140 x 140 x 125 mm) <sup>1</sup>                                  | 9.84 x 9.84 x 12.99 in (250 x 250 x 330 mm) <sup>1</sup>                                 | 10.82 x 10.82 x 16.53 in (275 x 275 x 420 mm) <sup>1</sup>   |
| Ready-to-run materials with developed print parameters: | Cobalt-Chrome CoCr<br>Stainless Steel 17-4 PH                   | Cobalt-Chrome CoCr<br>Stainless Steel 17-4 PH<br>Maraging Steel<br>Aluminum Alloy AISi12 | Cobalt-Chrome CoCr<br>Stainless Steel 17-4 PH<br>Maraging Steel<br>Aluminum Alloy AISi12 | LaserForm® Ti Gr. 1 <sup>2</sup><br>LaserForm® Ti Gr. 5 <sup>2</sup><br>LaserForm® Ti Gr. 23 <sup>2</sup><br>LaserForm® Ni718 <sup>3</sup><br>LaserForm® Stainless 316L <sup>3</sup> |
| Material Deposition                                     | Roller  | Roller   | Roller   | Scrapper   |
| Repeatability   | x=20 µm, y=20 µm, z=20 µm                                       |  |  |  |
| Minimum Feature Size                                    | x=100 µm, y=100 µm, z=20 µm                                     |  |  | 100 µm   |
| Typical Accuracy  | ± 0.1-0.2% with ± 50 µm minimum                                 | ± 0.1-0.2% with ± 50 µm minimum  | ± 0.1-0.2% with ± 50 µm minimum  | ± 0.1-0.2% with ± 50 µm minimum  |
| Space Requirements                                      |   |  |  |  |
| Dimensions, uncrated (WxDxH)                            | 48 x 31 x 77 in (120 x 77 x 195 cm)                             | 48 x 59 x 77 in (120 x 150 x 195 cm)   | 95 x 87 x 95 in (240 x 220 x 240 cm)   | 93 x 91 x 91 in (235 x 230 x 230 cm)   |
| Weight, uncrated  | 1000 kg (2200 lbs)  | Approx. 1500 kg (3300 lbs)   | Approx. 5000 kg (11000 lbs)  | Approx. 4700 kg (10500 lbs)  |
| Facility Requirements                                   |   |  |  |  |
| Electrical Requirements                                 | 230 V / 2.7 KVA / single phase                                  | 400 V / 8 KVA / 3 phase  | 400 V / 15 KVA / 3 phase   | 400V / 10 KVA / 3 phase  |
| Compressed Air Requirements                             | 6-8 bar   | 6-8 bar  | 6-8 bar  | 4-8 bar  |
| Gas Requirements  | Nitrogen or Argon, 6-8 bar                                      | Nitrogen or Argon, 6-8 bar   | Nitrogen or Argon, 6-8 bar   | Argon, 1.5-4 bar   |
| Water Cooling   | Not required  | Chiller included in printer  | Chiller included in printer  | Chiller supplied with printer  |
| Control System and Software                             |   |  |  |  |
| Software Tools  | ProX DMP Manufacturing, ProX DMP Dental for dental applications |  |  | DMP Software suite   |
| Control Software  | ProX Control v2   |  |  | DMP Software suite   |
| Operating System  | Windows 7   | Windows 7  | Windows 7  | Windows 7, 64 bit  |
| Input Data File Formats                                 | STL   | STL  | STL  | STL  |
| Network Type and Protocol                               | Ethernet 1 Gbps, RJ-45 Plug                                     |  |  | Ethernet 1 Gbps, RJ-45 plug  |
| Accessories   |   |  |  |  |
| Recycling System  | Optional external system  | Optional external system   | Automatic  | Optional external system   |
| Optional Accessories                                    |   |  |  | Optional secondary module for fast material exchange   |
| Handling  |   |  |  |  |
| Material Loading  | Manual  | Semiautomatic  | Automatic  | Manual   |
| Interchangeable Build Modules                           | No  | No   | No   | Yes  |
| Certification   | CE marked, TUV  | CE marked, TUV   | CE marked, TUV   | CE marked, TUV   |

<sup>1</sup> Including build plate. Maximum part size is dependent on geometry, among other factors.

<sup>2</sup> Set up A

<sup>3</sup> Set up B

# Metal Alloys for the ProX<sup>®</sup> DMP 100, 200, 300

Achieve the best part quality and mechanical properties with 3D Systems' ready-to-run materials with extensively developed print parameters.



| Properties   | Aluminium Alloy AlSi12 | CoCrMo Alloy <sup>4</sup> | Maraging Steel    | Stainless Steel 17-4 PH |
|--|------------------------|---------------------------|-------------------|-------------------------|
| Printer Availability                               | ProX DMP 200, 300      | ProX DMP 100, 200, 300    | ProX DMP 200, 300 | ProX DMP 100, 200, 300  |
| <b>Chemical Composition</b>                        |                        |                           |                   |                         |
| Al   | Balance                | -                         | -                 | -                       |
| C  | -                      | 0.0 - 0.02%               | ≤ 0.03%           | -                       |
| Co   | -                      | Balance                   | 9.0 - 11.0%       | -                       |
| Cr   | -                      | 28.0 - 30.0%              | -                 | 15.0 - 17.5%            |
| Cu   | -                      | -                         | -                 | 3.0 - 5.0%              |
| Fe   | -                      | 0.0 - 0.5%                | Balance           | Balance                 |
| Mn   | -                      | 0.0 - 1.0%                | ≤ 1.0%            | < 1.0%                  |
| Mo   | -                      | 5.0 - 6.0%                | 4.0 - 6.0%        | -                       |
| Nb   | -                      | -                         | -                 | 0.15 - 0.45%            |
| Ni   | -                      | -                         | 17.0 - 19.0%      | 3.0 - 5.0%              |
| Si   | 11.0 - 13.0%           | 0.0 - 1.0%                | ≤ 1.0%            | < 1.0%                  |
| Ti   | -                      | -                         | 0.9 - 1.0%        | -                       |
| Residuals  | < 0.6%                 | -                         | -                 | -                       |
| <b>Mechanical Properties<sup>1</sup> Condition</b> |                        |                           |                   |                         |
| Ultimate Tensile Strength                          | ASTM E8                |                           |                   |                         |
| As-built <sup>2</sup>                              | 480 MPa ± 20           | 1200 MPa ± 100            | 1110 MPa ± 50     | 1100 MPa ± 50           |
| After post heat treatment <sup>3</sup>             | 240 MPa ± 20           | 1260 MPa ± 100            | -                 | 1300 MPa ± 50           |
| Yield Strength                                     | ASTM E8                |                           |                   |                         |
| As-built <sup>2</sup>                              | 270 MPa ± 20           | 850 MPa ± 100             | 860 MPa ± 50      | 620 MPa ± 50            |
| After post heat treatment <sup>3</sup>             | 180 MPa ± 20           | 900 MPa ± 100             | -                 | 1100 MPa ± 50           |
| Elongation at Break                                | ASTM E8                |                           |                   |                         |
| As-built <sup>2</sup>                              | 5.5% ± 1.0             | 10% ± 2                   | 11% ± 3           | 16% ± 2.0               |
| After post heat treatment <sup>3</sup>             | 20% ± 4.0              | 15% ± 2                   | -                 | 10% ± 2.0               |
| Hardness   |                        |                           |                   |                         |
| As-built <sup>2</sup>                              | 137 ± 1.5 HB           | -                         | 37 ± 2 HRC        | 300 ± 20 HV5            |
| After post heat treatment <sup>3</sup>             | 90 - 95 HB             | 500 ± 20 HV5              | 55 ± 2 HRC        | 400 ± 20 HV5            |
| Density  | Approx. 100%           | Approx. 100%              | Approx. 100%      | Approx. 100%            |

<sup>1</sup> Parts built on a ProX DMP 200 Printer

<sup>2</sup> As-built refers to the state of components built on the ProX DMP 200 before any post processing except removal from the build platform

<sup>3</sup> Different post heat treatments might be applied for this type of alloy

<sup>4</sup> Ni-free alloy: this chemical composition is suitable for biomedical applications

ProX DMP 100, 200 and 300 printers feature the most flexible build parameter control settings in the industry. These open systems offer you the option to develop parameters and run any material in addition to 3D Systems' ready-to-run alloys.

# Metal Alloys for the ProX<sup>®</sup> DMP 320

Achieve the best part quality and mechanical properties with 3D Systems' ready-to-run materials with extensively developed print parameters.



| Properties                  | LaserForm <sup>®</sup> Ti Gr. 1 | LaserForm <sup>®</sup> Ti Gr. 5 | LaserForm <sup>®</sup> Ti Gr. 23 | LaserForm <sup>®</sup> Ni718 | LaserForm <sup>®</sup> Stainless 316L |
|-----------------------------|---------------------------------|---------------------------------|----------------------------------|------------------------------|---------------------------------------|
| <b>Chemical Composition</b> |                                 |                                 |                                  |                              |                                       |
| Al                          | -                               | 5.50-6.75%                      | 5.50-6.50%                       | 0.2-0.8%                     | -                                     |
| B                           | -                               | -                               | -                                | ≤0.006%                      | -                                     |
| C                           | ≤ 0.08%                         | ≤0.08%                          | ≤0.08%                           | ≤0.08%                       | ≤0.030%                               |
| Co                          | -                               | -                               | -                                | ≤1.00%                       | -                                     |
| Cr                          | -                               | -                               | -                                | 17.00-21.00%                 | 16.5-18.5%                            |
| Cu                          | -                               | -                               | -                                | ≤0.30%                       | -                                     |
| Fe                          | ≤ 0.20%                         | ≤0.30%                          | ≤0.25%                           | Balance                      | Balance                               |
| H                           | ≤ 0.015%                        | ≤0.015%                         | ≤0.012%                          | -                            | -                                     |
| Mn                          | -                               | -                               | -                                | ≤0.35%                       | ≤2.00%                                |
| Mo                          | -                               | -                               | -                                | 2.80-3.30%                   | 2.00-2.50%                            |
| N                           | ≤ 0.03%                         | ≤0.05%                          | ≤0.03%                           | -                            | ≤0.11%                                |
| Nb+Ta                       | -                               | -                               | -                                | 4.75-5.50%                   | -                                     |
| Ni                          | -                               | -                               | -                                | 50.00-55.00%                 | 10.00-13.00%                          |
| O                           | ≤ 0.18%                         | ≤0.20%                          | ≤0.13%                           | -                            | -                                     |
| P                           | -                               | -                               | -                                | ≤0.015%                      | ≤0.045%                               |
| S                           | -                               | -                               | -                                | ≤0.015%                      | ≤0.030%                               |
| Si                          | -                               | -                               | -                                | ≤0.35%                       | ≤1.00%                                |
| Ti                          | Balance                         | Balance                         | Balance                          | 0.65-1.15%                   | -                                     |
| V                           | -                               | 3.50-4.50%                      | 3.50-4.50%                       | -                            | -                                     |
| Y                           | -                               | ≤0.005%                         | ≤0.005%                          | -                            | -                                     |
| Residuals each              | ≤ 0.10%                         | ≤0.10%                          | ≤0.10%                           | -                            | -                                     |
| Residuals total             | ≤ 0.40%                         | ≤0.40%                          | ≤0.40%                           | -                            | -                                     |
| Traces                      | -                               | -                               | -                                | ≤0.001% Pb, Se each          | -                                     |

| Specifications            | Condition | LaserForm <sup>®</sup> Ti Gr. 1 | LaserForm <sup>®</sup> Ti Gr. 5                                   | LaserForm <sup>®</sup> Ti Gr. 23                                  | LaserForm <sup>®</sup> Ni718    | LaserForm <sup>®</sup> Stainless 316L                           |
|---------------------------|-----------|---------------------------------|---|---|---------------------------------|---|
| Young's Modulus           | ASTM E8M  | 105 - 120 GPa                   | 105 - 120 GPa   | 105 - 120 GPa   | 170 GPa ± 20 GPa                | 190 GPa   |
| Yield Strength (Rp 0.2 %) | ASTM E8M  | 350 MPa ± 30 MPa                | 950 MPa ± 30 MPa <sup>3</sup><br>1100 MPa ± 100 MPa <sup>4</sup>  | 850 MPa ± 100 MPa <sup>3</sup><br>1000 MPa ± 100 MPa <sup>4</sup> | 1075 MPa ± 100 MPa <sup>5</sup> | 330 MPa ± 50 MPa <sup>6</sup><br>470 MPa ± 70 MPa <sup>4</sup>  |
| Ultimate Tensile Strength | ASTM E8M  | 450 MPa ± 30 MPa                | 1030 MPa ± 20 MPa <sup>3</sup><br>1190 MPa ± 100 MPa <sup>4</sup> | 940 MPa ± 50 MPa <sup>3</sup><br>1080 MPa ± 100 MPa <sup>4</sup>  | 1350 MPa ± 100 MPa <sup>5</sup> | 550 MPa ± 50 MPa <sup>6</sup><br>600 MPa ± 100 MPa <sup>4</sup> |
| Elongation at Break       | ASTM E8M  | 30% ± 5%                        | 12% ± 2 % <sup>3</sup><br>8% ± 2% <sup>4</sup>                    | 15% ± 5 % <sup>3</sup><br>11% ± 3 % <sup>4</sup>                  | 15% ± 5% <sup>5</sup>           | 50% ± 10 % <sup>6</sup><br>40% ± 20 % <sup>4</sup>              |

<sup>1</sup> Values based on literature

<sup>2</sup> Dependent on surface orientation and part geometry

<sup>3</sup> After Hot isostatic pressing (HIP) post-processing

<sup>4</sup> After stress relief post-processing

<sup>5</sup> After hardening

<sup>6</sup> After full annealing

# Metal Alloys for the ProX<sup>®</sup> DMP 320 Continued

| Specifications                           | Condition                                    | LaserForm <sup>®</sup> Ti Gr. 1 | LaserForm <sup>®</sup> Ti Gr. 5                | LaserForm <sup>®</sup> Ti Gr. 23               | LaserForm <sup>®</sup> Ni718                     | LaserForm <sup>®</sup> Stainless 316L                             |
|--|--|---------------------------------|--|--|--|---|
| Micro Vickers Hardness                   |  | 195 ± 15 Hv0.3                  | -  | -  | -  | 210 - 215 Hv  |
| Macro Rockwell C Hardness                |  | -                               | > 30 HRC <sup>3</sup><br>> 33 HRC <sup>4</sup> | > 30 HRC <sup>3</sup><br>> 33 HRC <sup>4</sup> | 47 HRC <sup>5</sup>                              | -   |
| Thermal Conductivity <sup>1</sup>        | at 50 °C                                     | 16 W/m.K                        | 6.7 W/m.K                                      | 6.7 W/m.K                                      | 11.4 W/m.K                                       | at 20°C: 15 W/m.K<br>at 100°C: 16.3 W/m.K<br>at 500°C: 21.5 W/m.K |
| Coeff. of Thermal Expansion <sup>1</sup> | 20 - 100 °C                                  | 7.17 x 10-6/°C                  | 8.6 x 10-6/°C                                  | 8.6 x 10-6/°C                                  | -  | 0 - 100 °C: 16.4 x 10-6/°C  |
|  | 20 - 300 °C                                  | 9.4 x 10-6/°C                   | 9.2 x 10-6/°C                                  | 9.2 x 10-6/°C                                  | -  | 0 - 300 °C: 18.6 x 10-6/°C  |
|  | 20 - 700°C                                   | 10.1 x 10-6/°C                  | 9.7 x 10-6/°C                                  | 9.7 x 10-6/°C                                  | -  | -   |
| Specific Heat Capacity <sup>1</sup>      | 0-100°C                                      | -                               | -  | -  | -  | 500J/kg.K   |
|  | 20-200                                       | -                               | -  | -  | -  | 520 J/kg.K  |
|  | at 20 °C                                     | -                               | 580 J/kg.K                                     | 580 J/kg.K                                     | 435 J/kg.K                                       | -   |
|  | at 205 °C                                    | -                               | 610 J/kg.K                                     | 610 J/kg.K                                     | -  | -   |
|  | at 260 °C                                    | -                               | -  | -  | 520 J/kg.K                                       | -   |
|  | at 300°C                                     | -                               | -  | -  | -  | 550 J/kg.K  |
|  | at 399 °C                                    | -                               | -  | -  | 725 J/kg.K                                       | -   |
|  | at 425 °C                                    | -                               | 670 J/kg.K                                     | 670 J/kg.K                                     | -  | -   |
|  | at 468 °C                                    | -                               | -  | -  | 900 J/kg.K                                       | -   |
|  | at 500°C                                     | -                               | -  | -  | -  | 590 J/kg.K  |
|  | at 538 °C                                    | -                               | -  | -  | 700 J/kg.K                                       | -   |
|  | at 650 °C                                    | -                               | 760 J/kg.K                                     | 760 J/kg.K                                     | -  | -   |
|  | at 700°C                                     | -                               | -  | -  | -  | 630 J/kg.K  |
|  | at 870 °C                                    | -                               | 930 J/kg.K                                     | 930 J/kg.K                                     | -  | -   |
| Maximum Operating Temp. <sup>1</sup>     | 425 °C (continuous)<br>540 °C (intermittent) | -<br>-                          | -<br>-   | -<br>-   | 650 °C (loaded)<br>980 °C (oxidation resistance) | -<br>-  |
|  |  |                                 |  |  |  |   |
| Melting Point <sup>1</sup>               |  | 1668 °C                         | 1692 - 1698 °C                                 | 1692 - 1698 °C                                 | 1260 - 1335 °C                                   | 1375 - 1400 °C  |
| α/β Transus Temperature <sup>1</sup>     |  | 882 °C                          | 995 °C   | 995°C  | -  | -   |
| Magnetic Permeability <sup>1</sup>       |  | -                               | 1.00005  | 1.00005  | 1.0011   | 1.008   |
| Electrical Resistivity                   |  | -                               | -  | -  | -  | 740 nΩ.m  |
| Cytotoxicity (ISO 10993-5)               |  | Grade 0 (non cytotoxic)         | -  | Grade 0 (non cytotoxic)                        | -  | -   |
| Relative Density                         |  | Approx. 100%                    | Approx. 100%                                   | Approx. 100%                                   | Approx. 100%                                     | Approx. 100%  |
| Absolute Density <sup>1</sup>            |  | 4.51 g/cm <sup>3</sup>          | 4.41 g/cm <sup>3</sup>                         | 4.42 g/cm <sup>3</sup>                         | 8.2 g/cm <sup>3</sup>                            | 7.92 g/cm <sup>3</sup>  |
| Typical Surface Roughness <sup>2</sup>   |  |                                 |  |  |  |   |
|  |  |                                 |  |  |  |   |
| Ra                                       |  | 4 - 8 μm                        | 4 - 8 μm                                       | 4 - 8 μm                                       | 4 - 10 μm  | 4 - 6.5 μm  |
| Ry                                       |  | 25 - 35 μm                      | 25 - 35 μm                                     | 25 - 35 μm                                     | 20 - 50 μm                                       | 25 - 50 μm  |

<sup>1</sup> Values based on literature

<sup>2</sup> Dependent on surface orientation and part geometry

<sup>3</sup> After Hot isostatic pressing (HIP) post-processing

<sup>4</sup> After stress relief post-processing

<sup>5</sup> After hardening

<sup>6</sup> After full annealing

The ProX DMP 320 offers exchangeable manufacturing modules that support rapid material change or replenishment, in line with the printer configuration selected.