



CIB#: CIB\_00072\_Rev\_A

Date: January 2018

Status: Non-confidential

## **Subject: Tips and info for building with DuraForm® ProX™ EX BLK Engineered Thermoplastic on ProX™ SLS® systems**

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**DuraForm ProX EX BLK** is an engineered production plastic for use in 3D Systems' ProX SLS systems. It is considered a high performance material for use on a ProX SLS printer. DuraForm ProX EX BLK offers a combination of mechanicals, fine feature details, smooth surfaces, warpage and recyclability on a ProX SLS printer.

DuraForm ProX EX BLK is available in Standard Production (SP) Mode, and Advanced Mode. Material configuration files for SP and Advanced modes are offered by 3D Systems. The process settings in the SP configuration files have been optimized to provide a good starting point to operate while using this mode. Process settings for the Advanced configuration files offer more processing latitude for advanced users. SP Mode is the default configuration and the recommended mode by 3D Systems.

The material process parameter set points may vary slightly from machine to machine, due to differences in material conditions and thermal sensors. As a result, the process parameters, more specifically the temperature set points, may need to be adjusted slightly from the defaults. An offline IR sensor calibration is required before using a material for the first time.

Below are the important pieces of information to know in order to build successfully with DuraForm ProX EX BLK on a ProX SLS system. For more details about this material, please refer to the DuraForm ProX EX BLK material guide and for more details about the ProX SLS system, please refer to the ProX SLS user guide.

1. **Hardware Modifications:** Customers who desire to print DuraForm ProX EX BLK Plastic material will require upgrading some components in the printer.

**Counter Rotating Roller Upgrade:** An upgrade to the Counter-Rotating Roller is required in order to successfully print with DuraForm ProX EX BLK. Please contact your 3D Systems field service representative for more information upgrade. This upgrade is very critical for running DuraForm ProX EX BLK on a ProX SLS printer.

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**Hoper Feed Module (HFM) Heaters:** DuraForm ProX EX BLK Plastic material will require feeding warmer powder from the HFM. Please contact your 3D Systems field service representative to verify you require this upgrade.

**Feed Roller Seal:** DuraForm ProX EX BLK Plastic material will require feeding warmer powder from the HFM and may be more aggressive on some components. Please contact your 3D Systems field service representative to verify you require this upgrade.

2. **Software version:** DuraForm ProX EX BLK config files are supported with Sinter V6.1 and later versions.
3. **Build Preparation software:** SLS Build Packet Files are created in the build preparation software. A Build Packet File (BPF) contains special instructions that are system and material specific. The initial default parameter values, provided in

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the DuraForm ProX EX BLK material configuration files, are a good starting place for your initial builds. Modification to parameter values may be recommended based on application or system condition.

4. **Material Configuration files:** LS 6.1 material config files are available for download from the 3D Systems website, InfoCenter.3dsystems.com>ProductionPrinters>SLS. The values in the material configs will be a good starting point for initial builds with EX BLK.

**NOTE:** Two material configuration file are offered with DuraForm ProX EX BLK: SP mode and Advanced mode. SP mode contains the default values for general purpose part building. The material configuration file offers the recommended parameters. Customers running DuraForm ProX EX BLK may need to optimize certain parameters for their systems.

**NOTE:** A setting of 5 lpm for N2 laser window flow is recommended for DuraForm ProX EX BLK material.

5. **SP vs. Advanced mode:** SP mode controls the limits of the ProX SLS system to ensure customer get the performance they desire and removes variability that could occur during the standard print process. The Advanced mode offers more processing latitude for advanced users, and increases the allowed range for many of the parameter values.

The following table highlights the default process parameter values for the SP print mode

Parameter	DuraForm ProX EX BLK
Part Bed Heater Set Point	179.5°C
Powder Layer Thickness	0.1 mm
Fill Laser Power	85 W
Outline Laser Power	30 W
Scan Spacing	0.15 mm
Fill Scan Count	1
Outline Scan Count	1
SinterScan™	1

**NOTE:** It is the customer’s responsibility to validate results such as part quality and mechanical properties at the parameter values they use in Advanced Mode. Also, customers/users should note that 3DSystems Field Service might require the use of the SP mode during troubleshooting issues.

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6. **Shrink and Beam offsets:** The shrinkage of 100% fresh DuraForm ProX EX BLK is slightly higher than that of blended DuraForm ProX EX BLK. You should expect to evaluate and adjust the scale values used to compensate for shrink as the fresh powder ratio in the blend changes. Note that shrinkage may vary slightly based on part geometry. The following table offers the starting values to use for scale and beam offsets. These are the same values as in the material configuration file.

Parameter	DuraForm ProX EX BLK
X scale	1.04
Y scale	1.04
Z scale	1.0200-1.181E-5z
X Fill offset	0.300 mm
Y Fill offset	0.300 mm
X outline offset	0.280 mm
Y outline offset	0.280 mm

7. **Part orientation in the SLS build volume:** There are three primary considerations relative to part orientation.
- Large “blocky” sections or structures are susceptible to distortion (post-build curl). Rotating the .stl file a few degrees about X and/or Y can help to mitigate this distortion. Rotation to 30 degrees is shown to give good properties and less distortion.
  - Start these demanding parts later in the build (at greater Z) after other parts have already been built underneath.
  - Parts with wide flat bottoms are recommended to be oriented by 10 degrees in X and Y to eliminate distortion (i.e. bowing) at the bottom.
  - It is recommended to orient parts to match flat surfaces with the XY plane to reduce surface area on parts to optimize the flammability properties of the material. : There are three primary considerations relative to part orientation.
  - Large “blocky” sections or structures are susceptible to distortion (post-build curl). Rotating the .stl file a few degrees about X and/or Y can help to mitigate this distortion. Rotation to 30 degrees is shown to give good properties and less distortion.
  - Start these demanding parts later in the build (at greater Z) after other parts have already been built underneath.
  - Parts with wide flat bottoms are recommended to be oriented by 10 degrees in X and Y to eliminate distortion (i.e. bowing) at the bottom.
8. **LEAN:** Lean is a type of post build distortion. Lean occurs at the boundary of the acceptable build area, where the shrinkage of a part has different rates for different regions. Maintaining the most uniform temperature distribution, by modifying the various Heater Ratios, the Cylinder Heater Set Point, and the Piston Heater Set Point will minimize lean.

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9. **Routine maintenance:** Avoid leveling powder while purging the system. Exercise care when removing powder residue from sensitive surfaces. Powder build up should be vacuumed and oily residue should be wiped with a scratch-resistant cloth. Clean laser window with mild liquid detergent under running warm water, then clean with ethanol and a dust-free lens wiping tissue. Refer to the ProX SLS user guide and DuraForm ProX EX BLK material guide for more details.

10. **Material handling:** Follow proper PPE when handling DuraForm ProX EX BLK. This includes safety glasses, protective gloves, and a dust mask. Please refer to the ProX SLS user guide and the DuraForm ProX EX BLK material guide for more details.

**NOTE:** Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source may become a potential dust explosion hazard. The dust deflagration value ( $K_{st}$ ) is 75 bar-m/sec.

11. **Part Breakout, Powder Recycling & Sifting:** Do not remove the print cake from the process chamber until the part bed temperature is approximately 85°C. Allow parts to continue cooling to 50°C before trying to break them out of the print cake.

After a print, loose material can be sifted and reused in another print. Consistent recycling procedures are important in order to maintain consistent material properties. If recycling procedures are not followed, problems such as variable shrinkages and surface imperfections like "orange peel" may appear.

For the ProX SLS system, the part breakout, powder sifting and powder recycling operations are performed at a station called the Material Quality Control (MQC) System. The MQC is an integral part of the ProX SLS printer.

Remove loose powder surrounding the parts with a brush. Use a combination of part breakout tools and a bead blaster to fully remove the powder adhering to the parts. Sift the loose powder into the used bin of the MQC System. Discard any hard, chunky powder and the powder directly surrounding the parts.

The DuraForm ProX EX BLK Plastic material is a very fine blend of small particles. As you run prints, the material is exposed to heat and energy, and as a result the particles in the used powder tend to stick together forming larger particles. You can combat this trend with sifting and blending. Sifting removes undesirable particles from the used powder and blending incorporates new particles of appropriate size. Blending also helps combat the changes in material melt viscosity of the used powder by creating a final blend with uniform material melt viscosity that shows less variance from blend to blend.

12. **Blending Fresh and Used Powder:** The MQC blends the fresh and used powder. The ratio of the fresh to the used powder in a blend can be set for each material and blend. 3D Systems offers a recommended fresh powder ratio to use for each material.

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**NOTE:** For a ProX SLS system, there is no overflow powder to use for a blend unlike the previous generation SLS systems. The overflow powder is recirculated back into the feed hopper during the print process and is ultimately consumed for the print process.

The MQC initiates a blend cycle when it has enough material to blend a total of about 40 liters. For example, at a 80% fresh powder ratio, it requires about 32 liters in the fresh bin and about 8 liters in the used bin in order to initiate a new blend cycle. At any particular fresh powder ratio setting, the minimum volumes of fresh and used powder required to initiate a blend are displayed on the MQC home screen. [Please refer to the respective ProX SLS System user guides for more information on the MQC. The range for fresh powder ratio setting on the MQC System for DuraForm ProX AF+ material is from 60% to 100%.](#)

**The default fresh powder ratio setting for DuraForm ProX EX BLK material is 80%.**

**NOTE:** An 80% fresh powder ratio setting for DuraForm ProX EX BLK does not result in orange peel. Parts that are prone to distortion tend to print better (with less distortion) at 80% fresh powder ratio setting.

**NOTE:** Approximately 0.55 Kgs (1.3 liters) of powder is required for every 10 mm of z-height (please include warmup, build, and cooldown heights for calculation). This number holds true when the volume percentage of parts in a build is about 8%. For builds with higher part volume percentage a larger quantity of powder will be required. The Information tab in the build preparation software also provides the approximate volume of powder required to complete a build.

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