13 Al

22 Ti | 24 Cr | 26 Fe | 27 Co | 28 Ni | 29 Cu

X Line 2000R Aluminum Al-Si10-Mg

Parameter for GE Additive's Concept Laser X Line 2000R

Data in this material datasheet represents material built with a 40 and 60 µm layer thickness and in an argon or nitrogen atmosphere on a Concept Laser X Line 2000R. Values listed are typical.

Aluminum Al-Si10-Mg

Al-Si10-Mg has a chemical composition according to ASTM F3318 and is an essential Aluminum alloy in the world of additive manufacturing. As good casting alloy for complex geometries, it combines light weight and excellent thermal conductivity. The alloy is ideally suited for part designs with thin walls such as ductwork or heat exchangers. Once post-processed, parts offer good strength and hardness superior to conventionally cast material, as well as good dynamic properties for industries in the aerospace, automotive, automation and tooling sectors. In summary this aluminum alloy holds great promises to bring additive manufacturing to high volume consumer applications.

X Line 2000R Al-Si10-Mg

The Al-Si10-Mg parameters for the Concept Laser X Line 2000R are developed leveraging the performance of the previous X Line generations. The parameter were developed using plasma atomized Al-Si10-Mg powder from AP&C. The 40 µm parameter produces surface roughness less than 15 µm without bead blast or shot peening. Additionally, this parameter set is improved enabling thin feature printability for applications like heat exchangers. Moreover, the mechanical properties succeed the limits specified in ASTM F3318 for additive manufactured parts in the stress relieved (SR1) state. Higher productivity for e.g. prototyping applications can be gained by using the 60 µm parameter.

X Line 2000R Aluminum Al-Si10-Mg

With appropriate approval* Al-Si10-Mg can be used for lightweight components in aerospace and industrial applications. Data in this material datasheet represents material built with a 40 and 60 µm layer thickness and in an argon or nitrogen atmosphere on a Concept Laser X Line 2000R. Values listed are typical.

POWDER CHEMISTRY

Aluminum Al-Si10-Mg powder chemical composition according to ASTM F3318.
For additional information on Al-Si10-Mg powder, visit https://www.advancedpowders.com/powders/aluminum/al-si10-mg.

MACHINE CONFIGURATION

- Concept Laser X Line 2000R
- Argon and Nitrogen gas
- Rubber

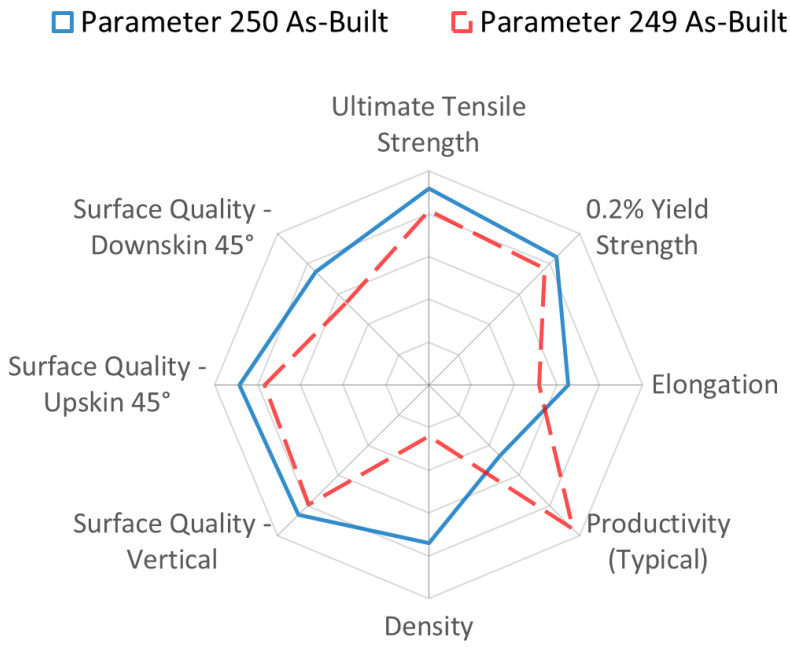
AVAILABLE PARAMETERS

- **Balanced Parameter 250** 40 µm layer thickness, argon gas, rubber recoater
- **Productivity Parameter 249** 60 µm layer thickness, nitrogen gas, rubber recoater

THERMAL TREATMENTS

1. As-Built
2. Stress Relief (SR1)
   Stress relief 295°C, 2 hours, cooled in air

PARAMETER COMPARISON (THERMAL STATE AS_BUILT)



Spider Plot is generated by normalizing typical material data (containing both horizontal and vertical data) against a range defined for each material family. For **Aluminum Alloys**, the ranges are as follows: UTS: 0-500 MPa, 0.2%YS: 0-300 MPa, Elongation: 0-20 %, Density: 99-100 %, Productivity: 5-60 cm³/h, Surface Quality (all): 40-5 µm

TYPICAL BUILD RATE

Balanced Parameter 250

	(cm³/h)
Typical build rate[1] w/coating	28.2
Theoretical melting rate[2] bulk per Laser	27.2

[1]Using standard Factory Acceptance Test layout and 2 lasers
[2]Calculated (layer thickness x scan velocity x hatch distance)

PHYSICAL DATA AT ROOM TEMPERATURE

	Surface Roughness Ra** - Overhang (µm)		
	45°	60°	75°
Upskin	9	10	10
Downskin	14	15	12

	Surface Roughness Ra** (µm)
H	21
V	10

	Porosity (% Density)		Hardness (HV5)		Poisson's Ratio	
Thermal State	H	V	H	V	H	V
As-Built	99.7	99.7	121	--	--	--
SR1	99.7	99.7	90.3	--	--	--

TENSILE DATA

Tensile testing done in accordance with ASTM E8 and ASTM E21

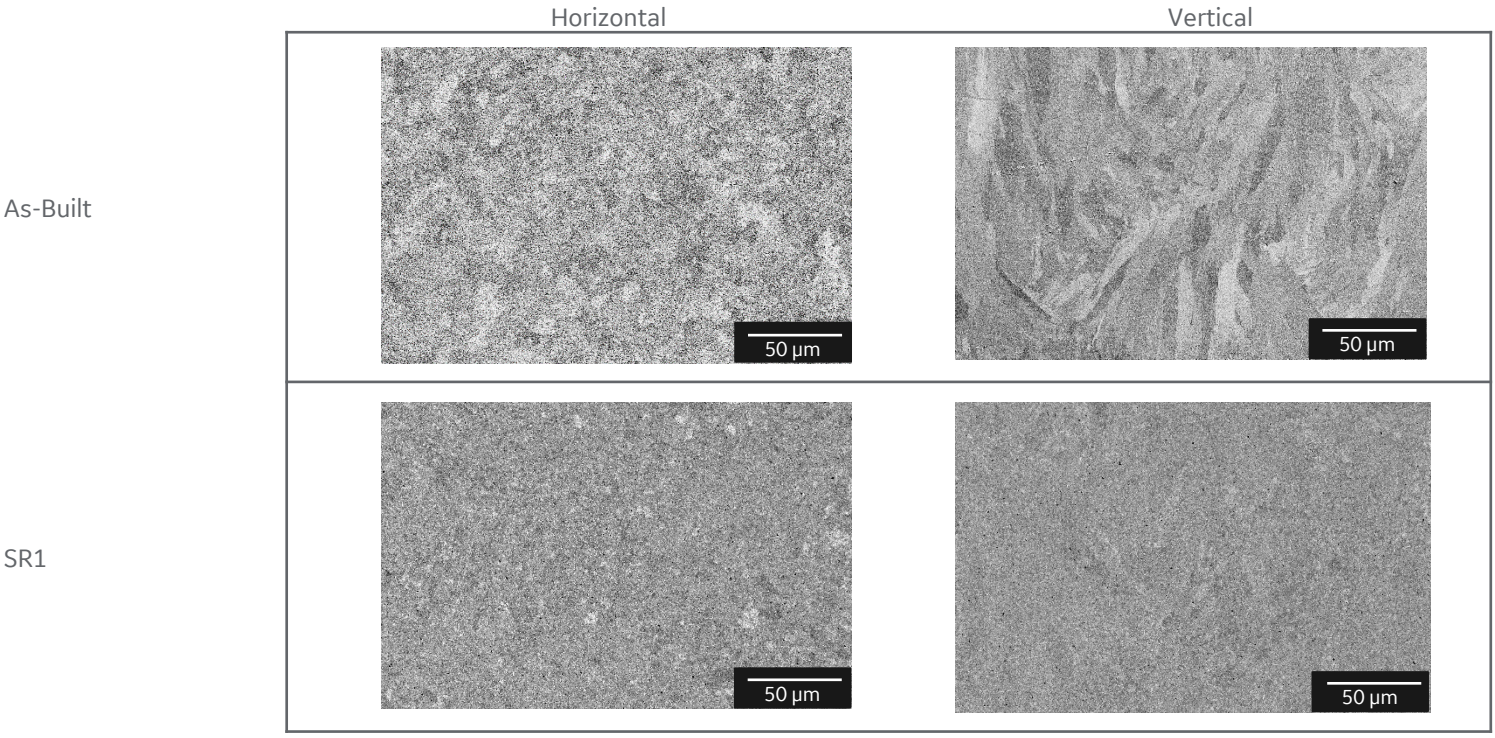
Test Temperature: RT

	Modulus of Elasticity (GPa)		0.2% Yield Strength (MPa)		Ultimate Tensile Strength (MPa)		Elongation (%)		Reduction of Area (%)	
Thermal State	H	V	H	V	H	V	H	V	H	V
As-Built	70	69	270	235	460	455	8.5	5.0	--	--
SR1	69	67	182	183	288	297	15.1	13.1	--	--

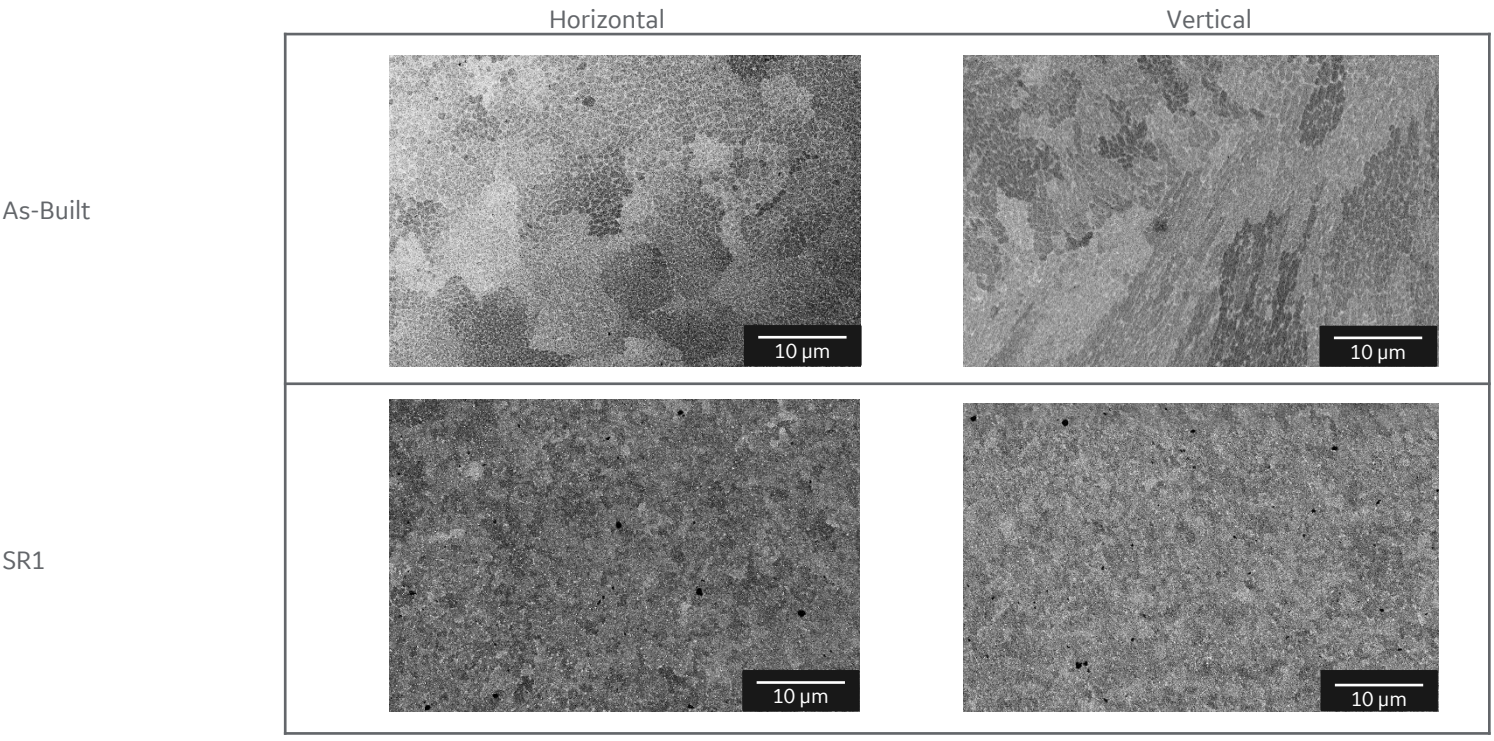
H: HORIZONTAL (XY) orientation
V: VERTICAL (Z) orientation

* All of the figures contained herein are approximate only. The figures provided are dependent on a number of factors, including but not limited to, process and machine parameters, and the approval is brand specific and/or application specific. The information provided on this material data sheet is illustrative only and cannot be relied on as binding.
** Roughness measurements have been performed according to DIN EN ISO 4287 and DIN EN ISO 4288. In general analysis of the surface quality is strongly dependent on the methodology used and therefore deviations might be observed depending on methodology used. Vertical and horizontal sidewalls have been characterized using a tactile system, overhangs using an optical system.

SEM IMAGES (low magnification)



SEM IMAGES (high magnification)



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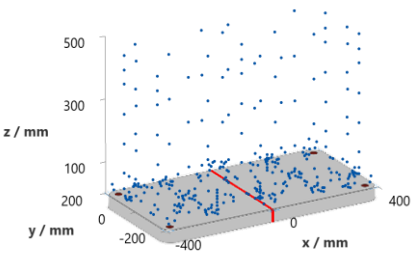
Within 3 platform stability builds porosity, roughness and tensile properties across different positions and orientations are evaluated. To illustrate the position dependency of the X Line 2000R, the samples were homogenously distributed across platform and height including refill zones. Regarding surface quality all sides of the specimen, so all orientations with respect to gas flow and optical system, are included in the analysis. Data shown below are dependent on part & print layout as well as batch chemistry variations and thus might deviate from “typical values” given on previous pages.

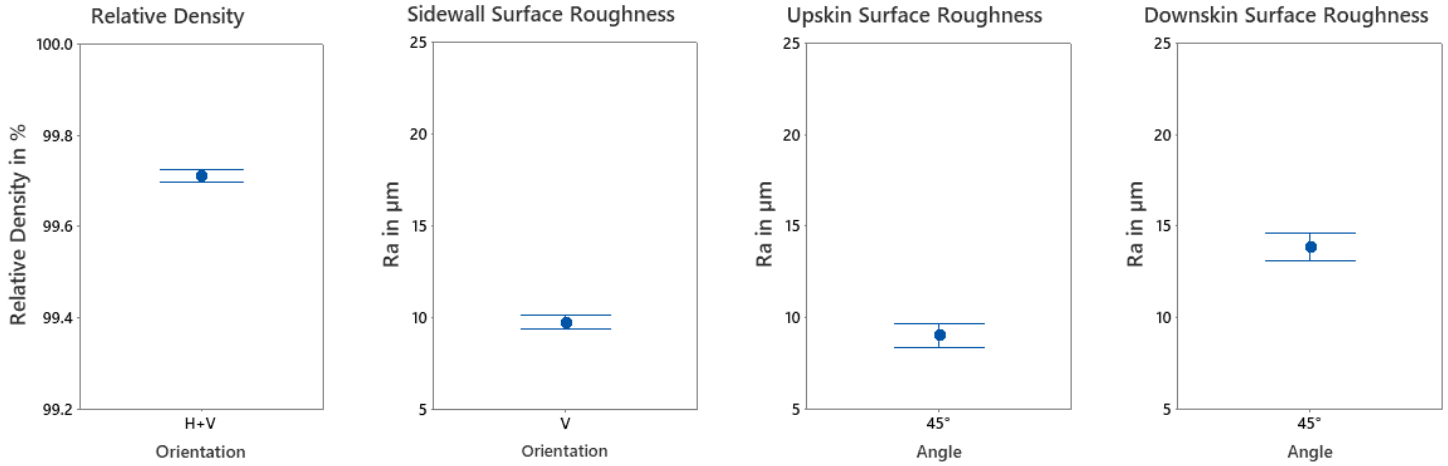
BUILD JOB DESIGN AND SUMMARIZED DATA (AS-BUILT)



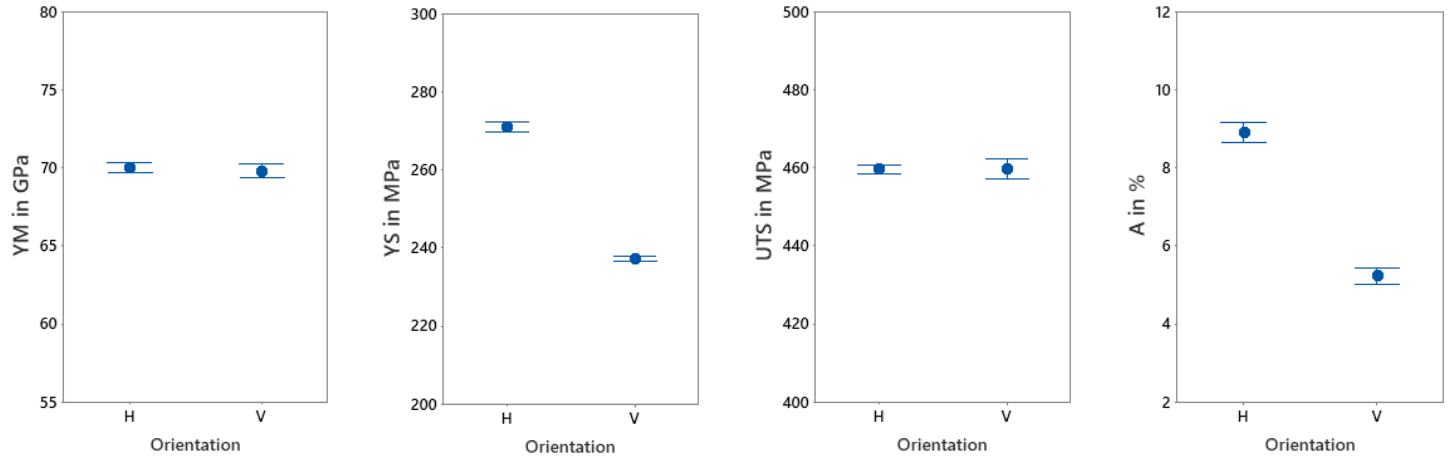
	Sample Size	Mean	St.Dev.
Rel. Density in %	141	99.71	0.09
Sidewall Roughness Ra in µm	144	10	2
Upskin Roughness Ra in µm (45°)	32	9	2
Downskin Roughness Ra in µm (45°)	32	14	2

	Sample Size	Mean	St.Dev.
YM in GPa (H/V)	36/102	70/70	1/2
YS in MPa (H/V)	36/102	271/237	4/3
UTS in MPa (H/V)	36/102	460/460	3/13
Elongation in % (H/V)	36/102	8.9/5.2	0.7/1.0

RESULTS – RELATIVE DENSITY AND SURFACE QUALITY



RESULTS - MECHANICAL PROPERTIES IN AS-BUILT CONDITION



Data points represent the mean value, intervals the 95% confidence level.

H: HORIZONTAL (XY) orientation
V: VERTICAL (Z) orientation

TYPICAL BUILD RATE

Productivity Parameter 249

	(cm³/h)
Typical build rate[1] w/coating	57.2
Theoretical melting rate[2] bulk per Laser	86.4

[1]Using standard Factory Acceptance Test layout and 2 lasers
[2]Calculated (layer thickness x scan velocity x hatch distance)

PHYSICAL DATA AT ROOM TEMPERATURE

	Surface Roughness Ra** - Overhang (µm)		
	45°	60°	75°
Upskin	14	12	10
Downskin	21	15	12

	Surface Roughness Ra** (µm)
H	37
V	13

	Porosity (% Density)		Hardness (HV5)		Poisson's Ratio	
Thermal State	H	V	H	V	H	V
As-Built	99.3	99.3	113	--	--	--
SR1	99.3	99.3	89	--	--	--

TENSILE DATA

Tensile testing done in accordance with ASTM E8 and ASTM E21

Test Temperature: RT

	Modulus of Elasticity (GPa)		0.2% Yield Strength (MPa)		Ultimate Tensile Strength (MPa)		Elongation (%)		Reduction of Area (%)	
Thermal State	H	V	H	V	H	V	H	V	H	V
As-Built	70	68	240	215	425	390	6.0	3.0	--	--
SR1	70	68	175	170	295	305	10.5	7.0	--	--

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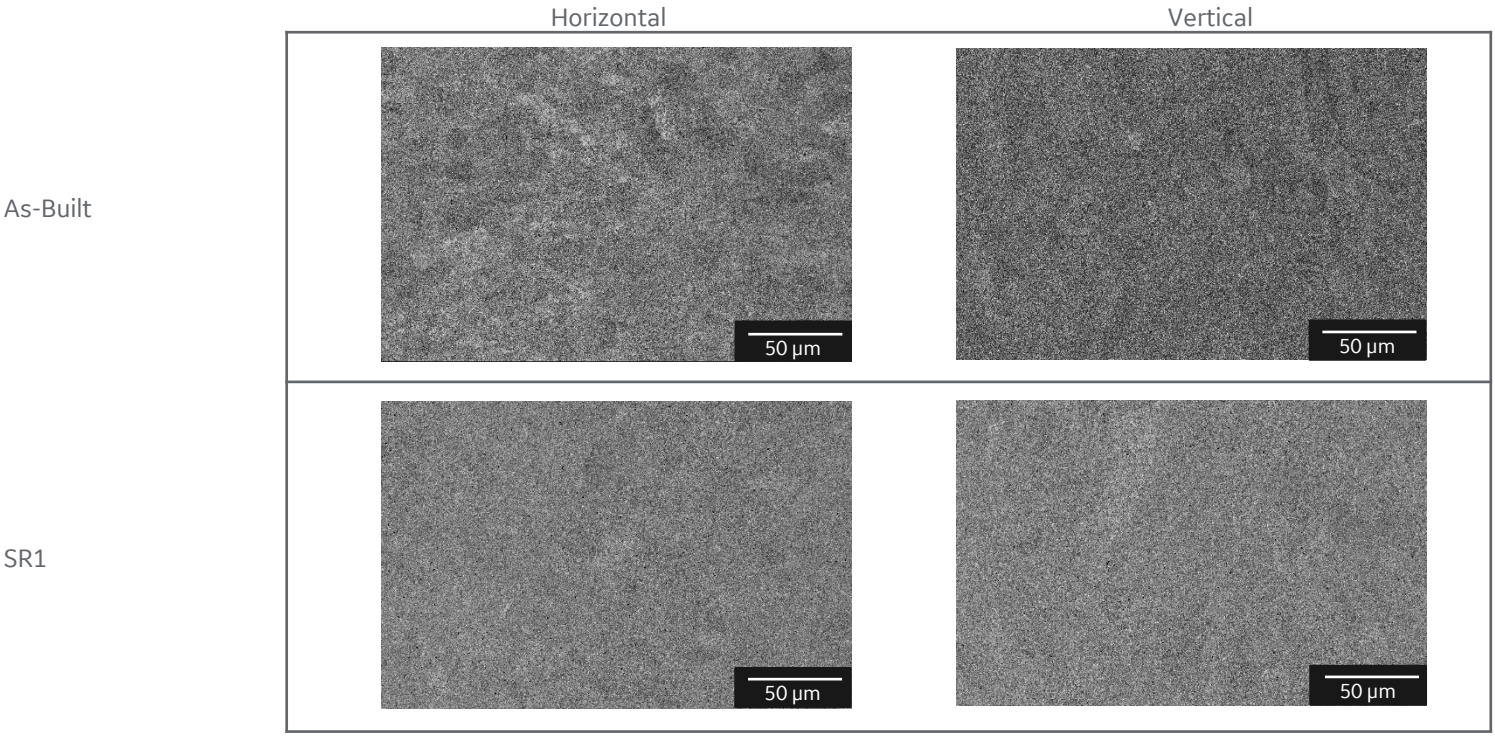
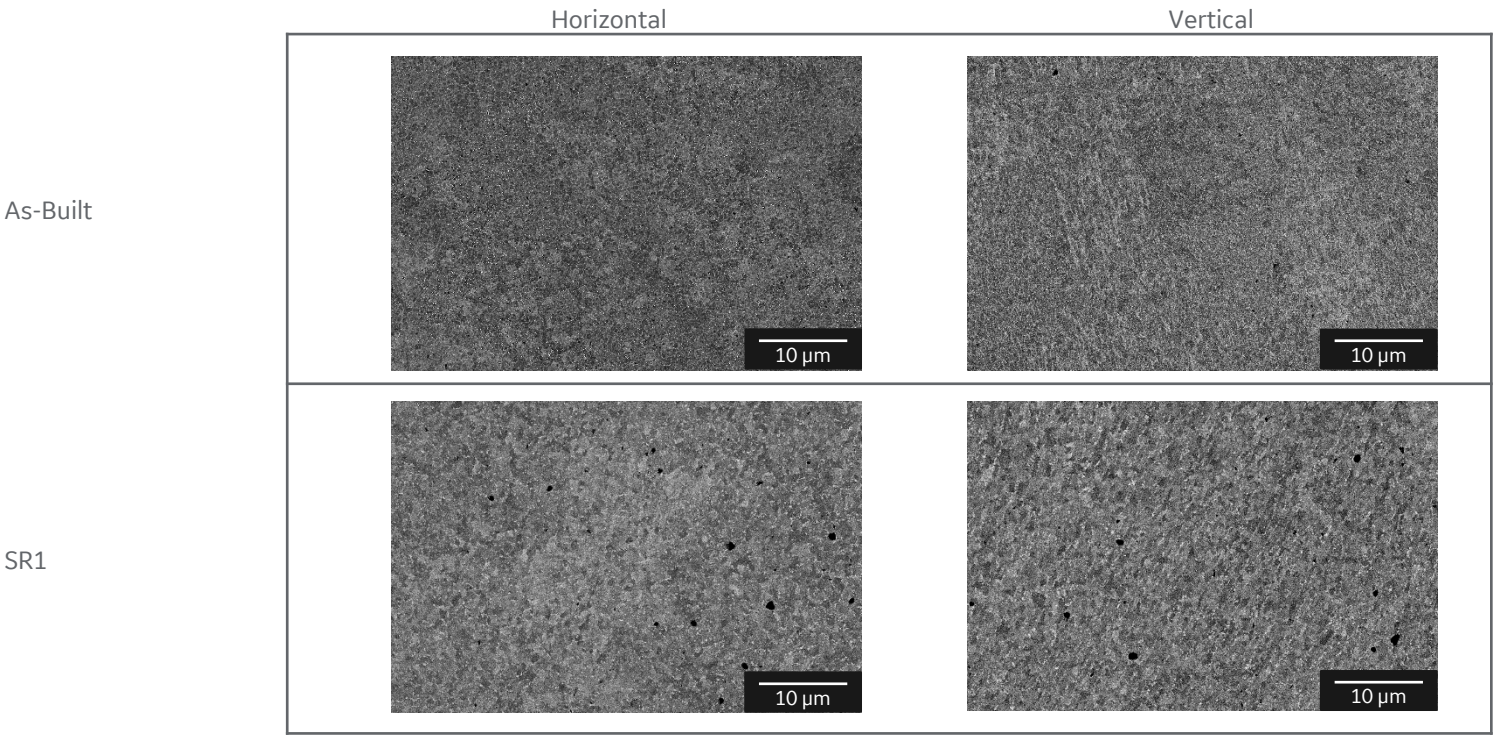
SEM IMAGES (low magnification)



SEM IMAGES (high magnification)



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