

## L-PBF Tool Steel CR-PH

Parameters for Colibrium Additive's M2 Series 5



### M2 Series 5 Tool Steel CR-PH

The CR-PH parameter has recently been developed for the Colibrium Additive M2 Series 5 machine.

The surface parameter is a 30  $\mu\text{m}$  parameter that produces surface roughness less than 4  $\mu\text{m}$  without bead blasting or shot peening for vertical sidewalls. In addition, this parameter was optimized to process thin-walled structures with high feature resolution and best quality.

### Tool Steel CR-PH

CR-PH is a precipitation hardening stainless steel with outstanding corrosion and wear resistance. Due to its chemical composition the hardness can be flexibly adjusted by an aging treatment and values up to 50 HRC can be reached. Next to that CR-PH shows good dimensional stability during heat treatment and favorable welding characteristics. Typical applications for CR-PH are molds for corrosive plastics, extrusion dies as well as engineering parts across various industries. Additive manufacturing offers new flexibility to design complex cooling channels and enable conformal cooling of e.g., injection molds. This can lead to significant cost savings by reduced cycle times and better part quality.



# M2 Series 5 Tool Steel Cr-PH

## Machine Configuration

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M2 Series 5

Single- or dual-laser architecture

Nitrogen gas

## Powder Chemistry

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CR-PH powder chemical composition close to PH 13-8 Mo (1.4534)

Particle size: 10 - 45  $\mu\text{m}$

## Thermal States

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As-Built (AB)

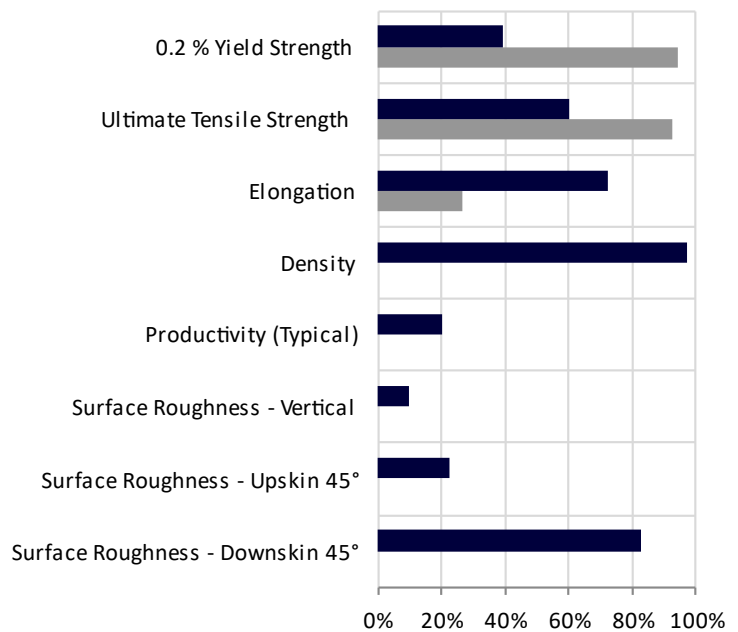
Solution Annealed + Age (SOLN + AGE)

SOLN: 850 °C for 0.5 hour in argon; AGE: 530 °C for 3 hours, cooling in air

## Parameter Availability and Thermal State Comparison

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- Surface Parameter 357 AB  
400 W, 30  $\mu\text{m}$  layer thickness, rubber recoater
- Surface Parameter 357 SOLN + AGE  
400 W, 30  $\mu\text{m}$  layer thickness, rubber recoater



Bar plot is generated by normalizing typical material data (containing both horizontal and vertical data) against a range defined for each material family. For CR-PH, the ranges are as follows: 0.2%YS: 0-1700 MPa UTS: 0-1800 MPa, Elongation: 0-20%, Density: 99-100%, Productivity: 5-40  $\text{cm}^3/\text{h}$ , Surface Quality (all): 0-40  $\mu\text{m}$ . 0% in the bar plot indicates the lower range value, 100% indicates the upper range value

## Surface Parameter 357 - 400 W / 30 μm

### Typical Build Rate

|  | (cm <sup>3</sup> /h) |
|--|----------------------|
| Typical build rate with coating <sup>1</sup>         | 12                   |
| Theoretical melting rate bulk per laser <sup>2</sup> | 9                    |

<sup>1</sup> Using standard Factory Acceptance Test layout and 2 lasers

<sup>2</sup> Calculated (layer thickness × scan velocity × hatch distance)

### Tensile Performance at Room Temperature

| Thermal State | Modulus of Elasticity (GPa) |     | 0.2% Yield Strength (MPa) |      | Ultimate Tensile Strength (MPa) |      |
|---------------|-----------------------------|-----|---------------------------|------|---------------------------------|------|
|               | H                           | V   | H                         | V    | H                               | V    |
| As-Built      | ---                         | --- | 640                       | 700  | 1075                            | 1090 |
| SOLN+AGE      | ---                         | --- | 1585                      | 1620 | 1650                            | 1680 |

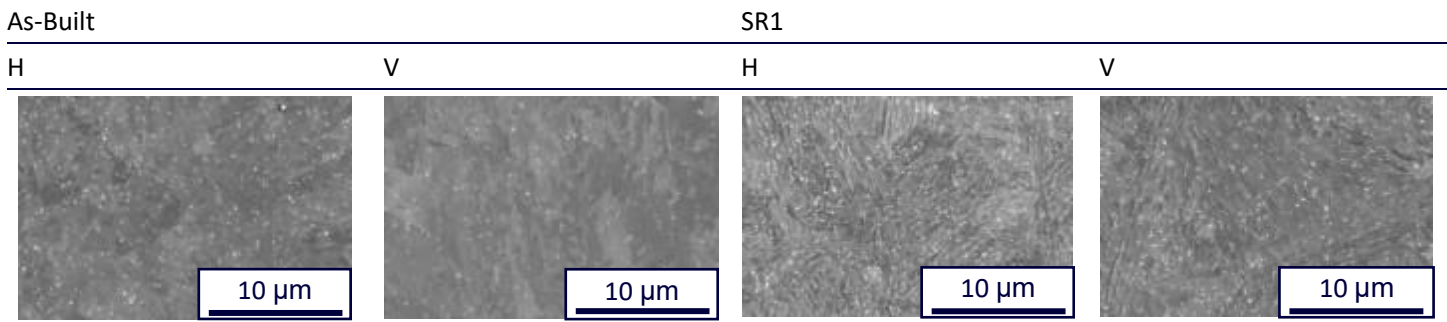
| Thermal State | Elongation (%) |    | Area Reduction (%) |    |
|---------------|----------------|----|--------------------|----|
|               | H              | V  | H                  | V  |
| As-Built      | 15             | 14 | 64                 | 63 |
| SOLN+AGE      | 6              | 3  | 26                 | 14 |

|          | Overhang Surface Roughness, Ra (µm) |     |     |
|----------|-------------------------------------|-----|-----|
|          | 45°                                 | 60° | 75° |
| Upskin   | 9                                   | 7   | 5   |
| Downskin | 33                                  | 18  | 5   |

| Surface Roughness, Ra (µm) |   |
|----------------------------|---|
| H                          | 6 |
| V                          | 4 |

| Thermal State | Relative Density (%) |      | Hardness (HV10) |
|---------------|----------------------|------|-----------------|
|               | H                    | V    |                 |
| As-Built      | 99.9                 | 99.9 | 345             |
| SOLN+AGE      | ---                  | ---  | 512             |

Microstructure



Scanning electron microscope images in As-Built and Solution Annealed + Age condition as defined previously.

## Data Sheet Nomenclature and Notation

H: Horizontal, perpendicular to build direction.

V: Vertical, parallel to build direction.

Other angles are measured from horizontal.

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.

Tensile evaluations were performed according to ASTM E8 or E21, depending on test temperature.

All figures and data contained herein are approximate and/or typical only and are dependent on several factors including but not limited to process and machine parameters. The information provided on this material data sheet is illustrative only and cannot be considered binding.