

Developed for Additive Manufacturing

Uddeholm

Corrax[®]

Uddeholm Corrax® for AM

Uddeholm Corrax is a stainless steel developed for Additive Manufacturing with a unique set of properties making it the ultimate choice for tools where superior corrosion resistance combined with high hardness is needed. These properties makes it perfectly suitable for tools for plastic molds including demanding applications such as moulds for medical parts, corrosive plastics i.e PVC and parts made of rubber material.

Uddeholm Corrax for AM offers high polishability in terms of surface finish and ease to process resulting in a high gloss surface suitable for challenging tooling applications.

The corrosion resistance is also beneficial when implementing complicated conformal cooling designs due to minimized risk for clogging of cooling channels, oxide layers reducing the cooling efficiency or corrosion initiated cracks.

The favorable chemical composition makes Uddeholm Corrax easy to process in additive manufacturing processes to get excellent printing results and excellent material properties.

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This information is based on our present state of knowledge and is intended to provide general notes on our products and their uses. It should not therefore be construed as a warranty of specific properties of the products described or a warranty for fitness for a particular purpose.

Classified according to EU Directive 1999/45/EC
For further information see our "Material Safety Data Sheets".

Edition 3, 09.2019



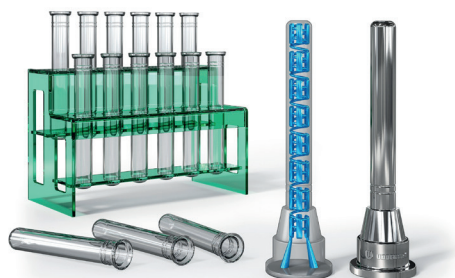
GENERAL

Uddeholm Corrax for AM offers several advantages compared to most tool steels for Additive Manufacturing:

- Excellent corrosion resistance
- Excellent polishability
- Flexible hardness, 36-50 HRC, achieved by an aging treatment in the temperature range 425-600°C (790-1110°F)
- Good dimensional stability during the aging treatment
- No hard “white” layer after EDM
- Easy to process in laser powder-bed as well as laser metal deposition equipment.

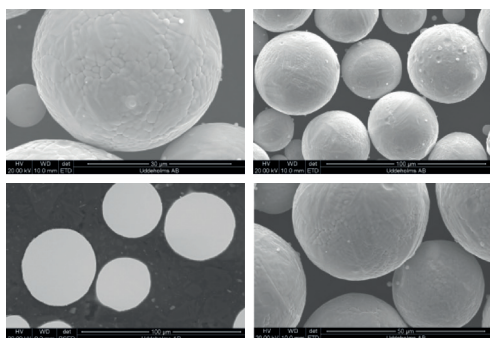
APPLICATIONS

- Injection moulds for
 - corrosive plastics
 - rubber
 - medical and food industry
- Plastizing technologies
 - Screws
- Engineering parts
- Medical tools and parts



POWDER CHARACTERISTICS

Typical analysis %	C	Si	Mn	Cr	Ni	Mo	Al
	0.03	0.3	0.3	12.0	9.2	1.4	1.6



SEM images of Uddeholm Corrax powder.

CHEMICAL COMPOSITION

POWDER MORPHOLOGY

Sphericity	0.93
Aspect Ratio	0.88
Apparent density	4300 kg/m ³
Tap density	5200 kg/m ³
True density	7610 kg/m ³

PARTICLE SIZE

Uddeholm Corrax for AM is sieved between 20 and 50 µm to a size distribution that suits most additive manufacturing equipment.

D10	D50	D90
25	38	48
≤10 µm max 1%		≥65 µm max 3%

PROPERTIES

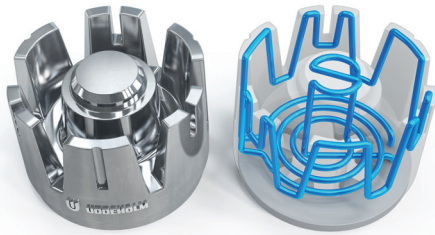
PHYSICAL DATA

The data was acquired from samples processed to >99.5 % density. Measured at room temperature on solution treated and aged material with a hardness of 48HRC.

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density kg/m ³ lbs/in ³	7 700 0.28	- -	- -
Modulus of elasticity N/mm ² psi	200 000 29 x 10 ⁶	190 000 28 x 10 ⁶	170 000 25 x 10 ⁶
Coefficient of thermal expansion per°C from 20°C per°F from 68°F	- -	11.7 x 10 ⁻⁶ 6.5 x 10 ⁻⁶	12.3 x 10 ⁻⁶ 6.8 x 10 ⁻⁶
Thermal conductivity W/m °C Btu in/ft ² h °F	- -	18 125	21 146

MECHANICAL DATA

	As build 34 HRC	Solution treated 34 HRC	Aged to 40 HRC	Aged to 50 HRC
Yield strength (Rp0,2) MPa PSI	760 110000	700 100000	1000 150000	1600 230000
Tensile strength (Rm) MPa PSI	1150 168000	1100 160000	1200 170000	1700 250000
Elongation A5%	16	15	16	10
Compressive strength MPa PSI	900 130000	900 130000	1300 190000	1800 260000

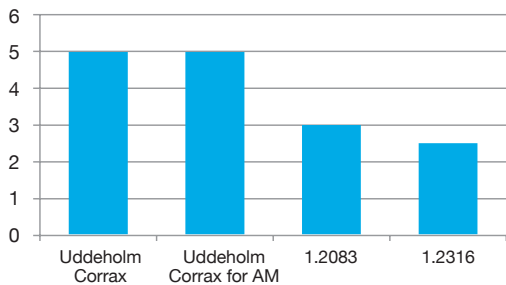


CORROSION RESISTANCE

Uddeholm Corrax for AM has excellent corrosion resistance, fully matching the conventionally manufactured Uddeholm Corrax and better than the corrosion resistant standard grades used for plastic moulding.

Uddeholm Corrax for AM will withstand most corrosive plastics and diluted acids. A mould insert made of Uddeholm Corrax will have good resistance to humid working and storage conditions. This steel grade shows better resistance to stress corrosion cracking than standard hardenable corrosion resistant steel grades.

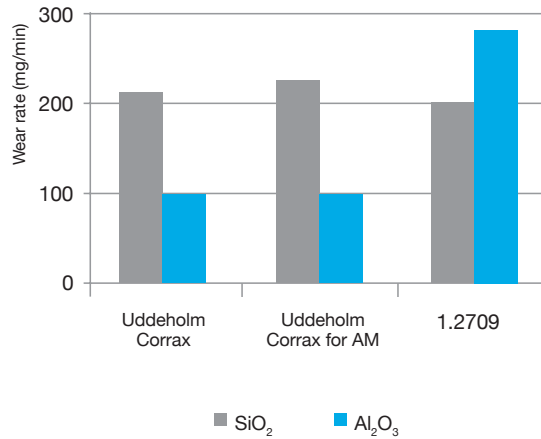
Corrosion resistance



WEAR RESISTANCE

Due to high hardness and fine microstructure Uddeholm Corrax for AM has an excellent wear resistance towards most media.

Abrasive wear test



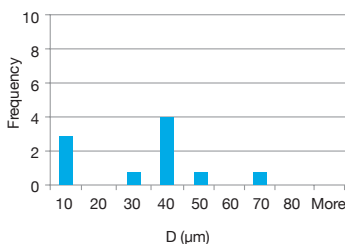
SiO₂ paper tested in dry condition. Al₂O₃ tested in wet condition.

SURFACE FINISH

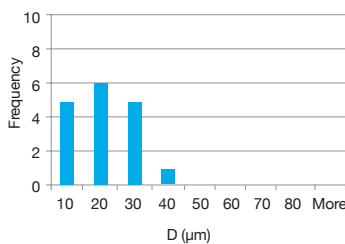
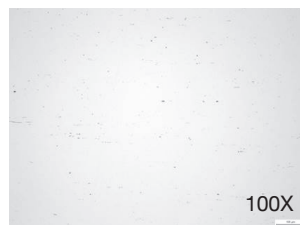
Uddeholm Corrax for AM offers extremely high polishing quality that results in excellent surface finish and a high gloss polished surface. When processed correctly Uddeholm Corrax for AM fully matches conventionally produced tool steels with its low amount of porosity and inclusions giving it perfect surfaces for high demanding tooling applications.

POLISHED SURFACE QUALITY

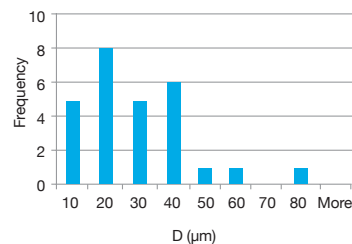
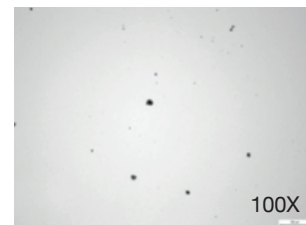
Uddeholm Corrax for AM



Uddeholm Corrax



1.2709 (M300)



Optical microscope images of polished surfaces and pit density measurements.

AM PROCESSING

Uddeholm Corrax for AM can be easily and efficiently processed in most powderbed laser additive manufacturing system.

Processing recommendations is available for most powder bed machines on the market, for further information please contact your local Uddeholm office.

POST PROCESSING

SOLUTION TREATMENT

In the as-build condition Uddeholm Corrax for AM material can contain up to 20 % retained austenite. The retained austenite content can be reduced to about 4% after solution treatment.

Solution treatment should be performed at 850°C, holding time 30 minutes and then cool in air.

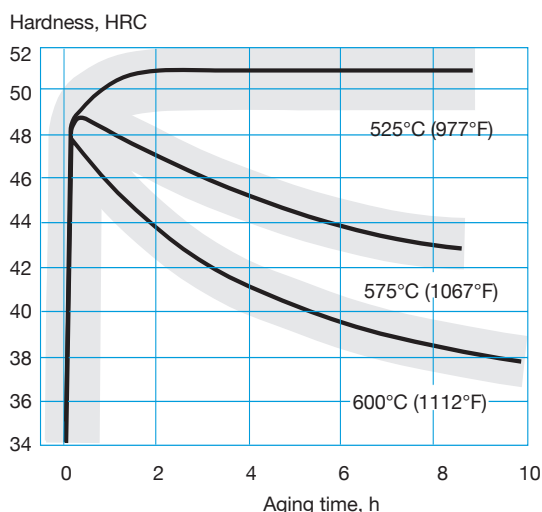
AGEING

Suitable ageing parameters can be obtained from the figure below. Ageing time means the time at the ageing temperature after the tool is fully heated through.

When the ageing time is reached, cool the tool in air to room temperature. Ageing at high temperature gives a better toughness. compared with ageing to the same hardness at a lower temperature.

Uddeholm Corrax for AM can be used in as-built condition but higher hardness is obtained by ageing.

Ageing temperature/time	Hardness
525°C/4 h (977°F/4 h)	49-52 HRC
575°C/4 h (1067°F/4 h)	44-47 HRC
600°C/4h (1112°F/4h)	40-43 HRC



STRESS RELIEVING

Uddeholm Corrax doesn't need stress relieving after the AM process.

Stress relieving cannot be performed as for other steel grades since an increase in temperature results in a higher hardness because of ageing effect.

DIMENSIONAL CHANGE

Uddeholm Corrax for AM is not subjected to any phase transformations during heat treatment which keeps deformations at a minimum.

Ageing results in a small and uniform decrease in volume. The following shrinkage can be expected during ageing.

Ageing	Dimensional change %		
	Longitudinal direction	Transversal direction	Short transversal direction
525°C/4 h (977°F/4 h) ~50 HRC	-0.07	-0.07	-0.07
575°C/4 h (1067°F/4 h) ~46 HRC	-0.09	-0.09	-0.09
600°C/4 h (1112°F/4 h) ~40HRC	-0.14	-0.14	-0.14

Solution annealing: 850°C/ 30min/ air cooled.

Ageing: 525°C/ 4h / air cooled

EDM

This AM steel grade can be EDM'd in the same way as ordinary tool steels. The "white layer" will, however, not be as hard and is therefore more easily removed.

GRINDING AND POLISHING

A general grinding wheel recommendation is given below. More information can be found in the Uddeholm publication "Grinding of Tool Steel".

Type of grinding	Delivery condition and aged condition
Face grinding straight wheel	A 46 GV
Face grinding segments	A 36 FV
Cylindrical grinding	A 60 JV
Internal grinding	A 60 IV
Profile grinding	A 120 JV

When good surface finish is required a SiC-wheel could be an alternative.

Uddeholm Corrax for AM exhibits excellent polishability behavior in both as-built and heat-treated conditions. A slightly different and more demanding technique is needed when polishing corrosion-resistant tool steels. and usually more steps are required between fine grinding and polishing stages.

But on the contrary, for Uddeholm Corrax for AM after rough and fine grinding it is possible to achieve high quality gloss surface finish with only three steps between lapping and polishing stages. For more detailed recommendations please refer to the



"Uddeholm polishing of mould steel" data sheet.

SURFACE COATING

PVD coating can be used to increase the surface hardness but all PVD coatings will lead to a substantial reduction of the corrosion resistance.

Low temperature plasma nitriding can be performed to increase surface hardness while maintaining corrosion properties, but the process temperature should not exceed 450°C.

For further information please contact your local Uddeholm office.

TEXTURING

Texturing can be made by direct laser cutting.

For chemical etching is a ferritic acid recommended.

LASER METAL DEPOSITION

The powder is available for laser metal deposition in the size fraction 50-150µm that works for most laser metal deposition equipment. Uddeholm Corrax for AM is easy to process and will in the as-cladded condition have a hardness of about 35 HRC.

But with annealing at 525°C Uddeholm Corrax for AM gets a hardness of 48 HRC and the same excellent corrosion resistance as conventionally produced Uddeholm Corrax.

APPROVALS

MEDICAL

Uddeholm Corrax for AM has been tested and approved for toxicology according to ISO 10993.

OTHER PRODUCTS AND SERVICES

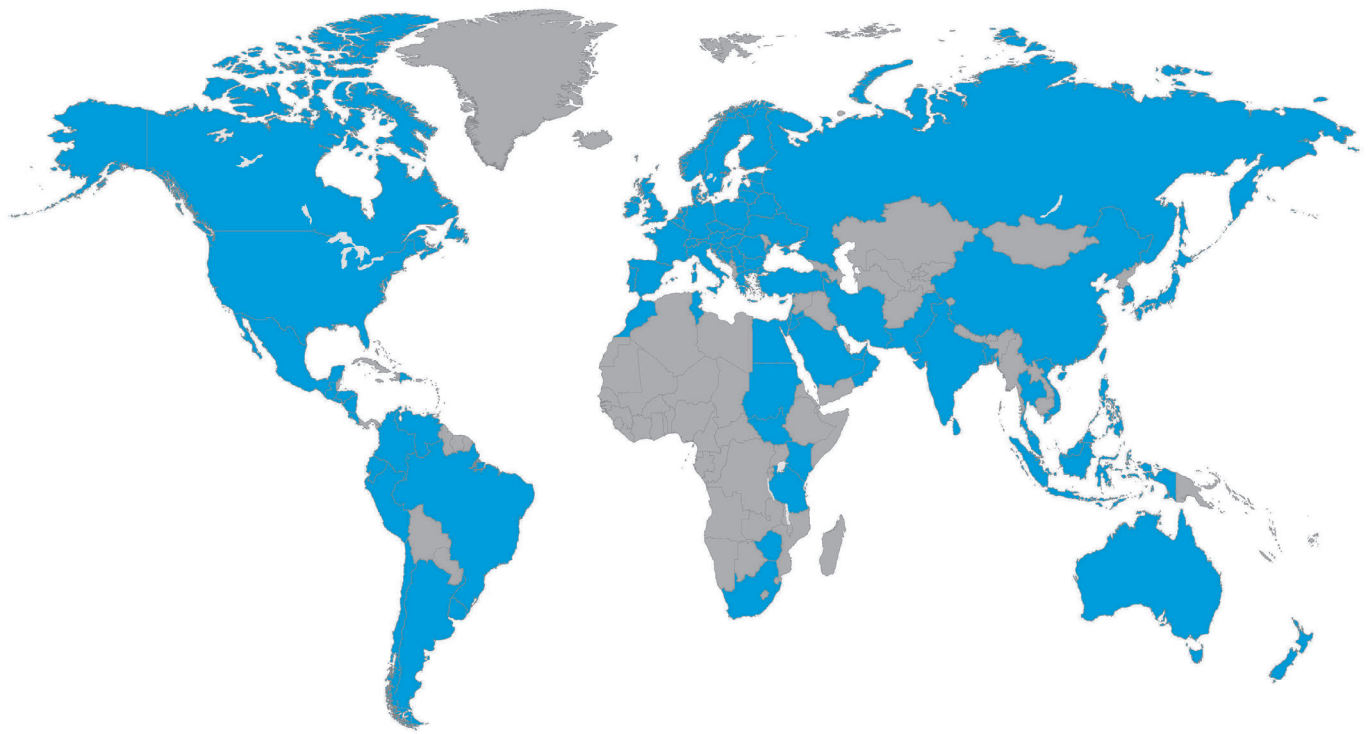
BUILD PLATES

To get optimal quality of your hybrid builds is the best choice to use Uddeholm Corrax plates. The build will then have the same properties throughout the part.

Pre-machined buildplates are available in suit-able dimensions.

FURTHER INFORMATION

Please, contact your local Uddeholm office for further information on the selection, heat treatment, application and availability of Uddeholm tool steels.



NETWORK OF EXCELLENCE

Uddeholm is present on every continent. This ensures you high-quality Swedish tool steel and local support wherever you are. We secure our position as the world's leading supplier of tooling materials.

Uddeholm is the world's leading supplier of tooling materials. This is a position we have reached by improving our customers' everyday business. Long tradition combined with research and product development equips Uddeholm to solve any tooling problem that may arise. It is a challenging process, but the goal is clear – to be your number one partner and tool steel provider.

Our presence on every continent guarantees you the same high quality wherever you are. We secure our position as the world's leading supplier of tooling materials. We act worldwide. For us it is all a matter of trust – in long-term partnerships as well as in developing new products.

For more information, please visit www.uddeholm.com