BÖHLER

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BÖHLER M789
AMPO

Additive
Manufacturing
Powder

ADDITIVE MANUFACTURING POWDER

A logical step for BÖHLER
one giant leap for the 3D printing industry.

voestalpine BÖHLER Edelstahl GmbH & Co KG
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ONE STEP AHEAD.

ADDITIVE MANUFACTURING
FUTURE BECOMES REALITY

Additive Manufacturing offers a multitude of advantages compared to conventional manufacturing methods like design freedom, shorter lead times or minimum tooling costs. However, up to now there have been only a limited number of commercial alloys available for Additive Manufacturing.

Since the performance-requirements of the printed parts in several applications like tooling, aerospace and automotive industry are getting more complex in terms of mechanical properties and corrosion resistance, the powder materials for Additive Manufacturing processes also have to be improved. We as voestalpine BÖHLER Edelstahl use our extensive metallurgical knowledge and manufacturing options to develop customer–specific powders to fulfil the desired requirements.

DEVELOPING THE FUTURE

Maraging grades are very commonly used powders in Additive Manufacturing. Due to their low carbon content, they allow an excellent processability in the Laser Powder Bed Fusion (L-PBF) process. 1.2709, for example, shows an outstanding combination of hardness and toughness values, but is not corrosion resistant. 17-4 PH on the other hand, exhibits good corrosion resistance, but does not reach the high maximum hardness of 1.2709. Therefore, a brand new maraging steel concept has been developed which combines the excellent corrosion resistance of 17-4 PH and the hardness of 1.2709. The BÖHLER M789 AMPO.

SPECIAL ALLOY DESIGN MAKES IT POSSIBLE

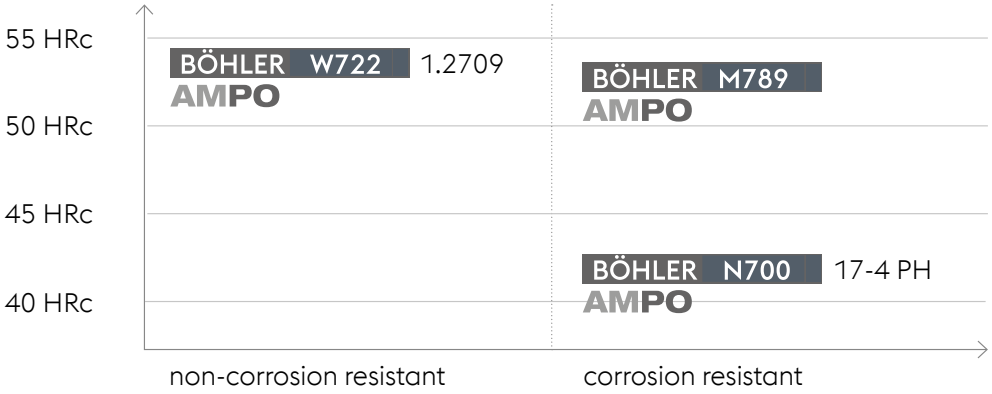
The base for the BÖHLER M789 AMPO is the widely known PH 13-8 Mo steel, which achieves a good hardness in combination with an excellent corrosion resistance. The aim for BÖHLER M789 AMPO to combine a high hardness level with good corrosion resistance, provide easy print- and weldability as well as a simple heat treatment with minimal distortion. Since the future demand of cobalt will rise due to the battery production for e-mobility, this corrosion resistant maraging steel grade was developed without cobalt.

To fulfil all expectations in one grade, developers at the R&D department of voestalpine BÖHLER Edelstahl have been very busy creating possibilities for such an improvement. The special alloy design of BÖHLER M789 AMPO with its tailored chemical composition fulfils all those requirements. Due to the formation of intermetallic precipitations containing Ni, Ti, Al and Si it is possible to achieve a hardness above 52 HRc with high corrosion resistance comparable to that of PH 13-8 Mo.

BÖHLER M789 AMPO

Manufacturing technology and continuous process control ensure spherical powder with optimal properties for 3D printing.

Comparison of maraging AM grades



BÖHLER grade	Mass - %	C	Si	Cr	Ni	Co	Mo	Al	Ti	Cu
BÖHLER W722 AMPO	1.2709	< 0.03	< 0.1	–	18.0	9.0	5.0	–	1.0	–
BÖHLER N700 AMPO	17-4 PH	< 0.07	< 0.7	17.0	4.0	–	0.3	–	–	3.3
BÖHLER N709	PH 13-8 Mo	< 0.02	< 0.8	12.5	8.0	–	2.0	1.0	–	–
BÖHLER M789 AMPO	*****	**< 0.02**	**0.5**	**12.2**	**10.0**	**Co free**	**1.0**	**0.6**	**1.0**	**–**

* also available as bar material BÖHLER M789VMR; Details on request

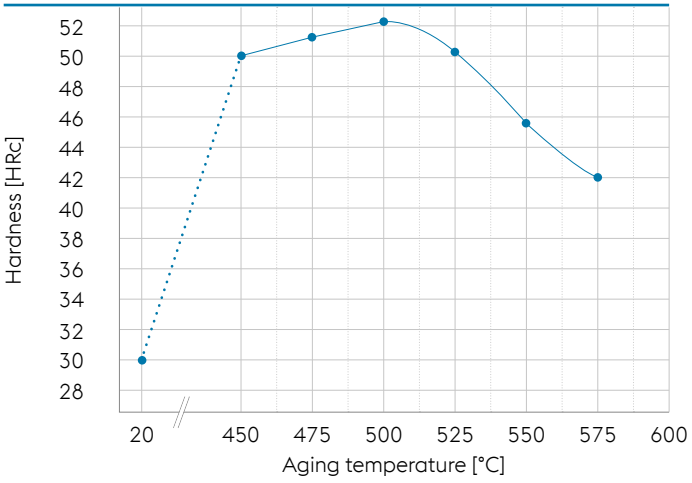
UNLEASH THE POWER

Printing trials on several AM-machines showed a wide field of successful parameter-combinations which makes the BÖHLER M789 AMPO **very printable**. To gain the full power of the material a heat treatment consisting of solution annealing and ageing has to be done. Therefore, it is advised to do the solution annealing at 1000°C with a soaking time of 1 hour. Air cooling of the material is possible. To achieve a hardness level of 52 HRc an aging treatment at a temperature of 500°C with 3 hours soaking is recommended.

The corrosion resistance is crucial when the steel is in contact with aggressive media which are very common in plastic injection moulding or in oil and gas industry applications. To evaluate the corrosion behaviour, pitting potential tests in in acidic mediums (pH=4; synthetic sea water + HCl) were performed. The BÖHLER M789 AMPO shows similar corrosion resistance as PH 13-8 Mo (BÖHLER N709) and exhibits a significant higher in corrosion resistance than martensitic stainless steels such as 1.2083.

BÖHLER M789 AMPO

Heat Treatment



ACHIEVABLE MECHANICAL PROPERTIES OF PRINTED PART AFTER HEAT TREATMENT

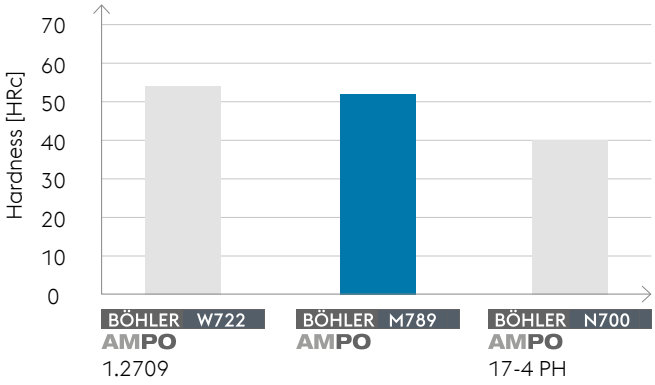
Tensile strength (Rm)	Yield strength ($Rp_{0,2}$)	Elongation (%)	Hardness	Ductility (ISO V)
1780 – 1880 MPa	1760 – 1810 MPa	4.5 – 7.6	50 – 54 HRc	6 – 14 J

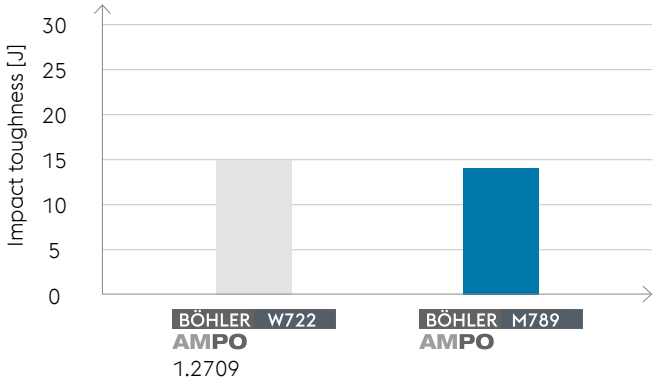
PARTICLE SIZE DISTRIBUTION*

15 - 45 µm (e.g. laser powder bed fusion)		**45 - 150 µm** (e.g. direct laser deposition)	
Flowability* [s]**	**Apparent density* [g/cm³]**	**Flowability* [s]**	**Apparent density* [g/cm³]**
4.80	3.69	18	3.92

* Measurement of particle size distribution is based on ISO 13322-2 (Dynamic image analysis methods); Flowability and apparent density are based on DIN EN ISO 4490 resp. DIN EN ISO 3923-1.

** Carneyflow ASTM B964





SUMMARY

Additive Manufacturing has become a part of the industry for producing prototypes or parts in small and medium batch sizes. Furthermore the requirements on the properties of the printed parts are steadily growing when it comes to corrosion resistance and the need of a higher hardness. The new BÖHLER M789 AMPO of voestalpine BÖHLER Edelstahl offers a solution to achieve high hardness as well as a brilliant corrossion resistance combined in one material.
For hybrid part solutions this material is also available as solid bar called BÖHLER M789VMR.

Tensile strength (Rm)	1780 – 1880 MPa
Yield strength ($Rp_{0,2}$)	1760 – 1810 MPa
Hardness	50 – 54 HRc
Elongation (%)	4 – 8 %
Toughness (ISO V)	6 – 14 J

BÖHLER M789 AMPO

At a glance

- **» High Hardness > 52 HRC**
- **» Excellent Toughness at this high Hardness**
- **» Excellent Corrosion Resistance**
- **» Superb Polishabiltiy**
- **» Easily Printable**
- **» BÖHLER M789VMR for hybrid part printing**
- **» no subject in the dual-use regulations (Powder and Bar)**

Within our group structure we do not offer only powder, but also the corresponding printing competence.
We achieve this through close cooperation with our global development and testing centers.

ABOUT THE AUTHOR:

voestalpine Böhler Edelstahl is worldwide one of the leading Special Steel and Special materials supplier. We develop, produce and deliver high speed steels, tool steels and special materials worldwide, to provide our customers with exemplary solutions.

DANIEL DIEPOLD

BUSINESS DEVELOPMENT
ADDITIVE MANUFACTURING POWDER

Daniel Diepold started his career in the technical department at voestalpine BÖHLER Edelstahl being responsible for powder metallurgical and conventional produced high speed steels and tool steels. Since 2019 he is working in the business development for additive manufacturing powders, bringing all together an experience of 9 years in powder metallurgical produced materials.

BÖHLER M789 AMPO

Focussing on the needs of our AM-customers results into the development of BÖHLER M789 AMPO → it combines easy printability, outstanding mechanical properties and high corrosion resistance in one grade. With this cutting-edge material we create a real value added to our customers. By offering this grade also as bar material, we provide a perfect solution for hybrid parts too.

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