

The world's hardest steel

Improve your existing HSS applications that need higher hot hardness or higher abrasion resistance. 3D printed Vibenite® 290 has supreme wear resistance and hardness, thanks to the high carbide content. It offers the possibility to design complex geometries, combine several parts into one, add channels for media, reduce weight, and add other features thanks to the additive manufacturing process. The turnaround time for prototyping and pre-series production is extremely fast, which makes it possible to develop new products quickly. What is more, no soft machining and less grinding are needed, thanks to the near-net-shape deliveries.



Benefits:

- The world's hardest steel, 72 HRC
- Excellent wear resistance
- No porosities and full hardness all the way through
- Uniform material microstructure, thanks to the AM-HSS™ process
- 3D printable

The world's hardest steel

Description

The hardest commercially-available steel type in the world: possible to harden up to approx. 72 HRC. Vibenite® 290's high Co content gives a very heat-resistant hard alloy, while its high quantity of carbide formers generates extreme levels of carbides. The result is outstanding wear resistance with an exceptional combination of toughness and hardness.

It is possible to purchase the powder as part of a licence agreement and manufacture the alloy in-house, or use VBN's manufacturing service where the customer supplies the drawings and VBN prints the near-net-shape details with an added grinding allowance. Finished, 3D printed blanks are then sent to the customer.

This alloy is a good substitute for cemented carbide (hard metal) in many applications.

Typical applications

The unique composition of Vibenite® 290 results in a material perfect for metal-cutting tool applications such as gear-cutting hobs, power-skiving cutters, shaper cutters and dry-cutting applications.

The material is also very suitable in abrasive and/or erosive wear applications.

This new alloy gives users a unique opportunity to choose the best performance for the application without having to resort to difficult machining.

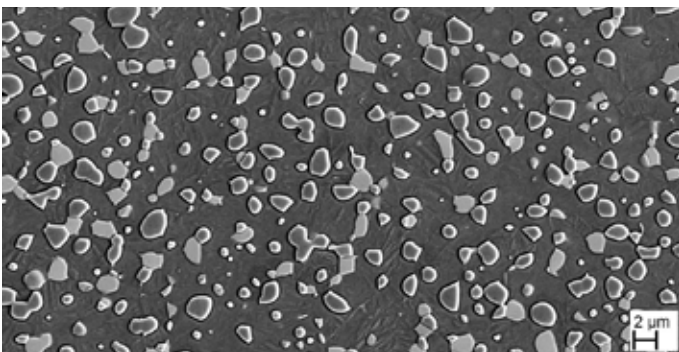
CHEMICAL COMPOSITION (WT%)

C	Cr	Mo	W	Co	V	Fe
2.5	4.0	5.0	11.0	16.0	6.3	Bal

PHYSICAL PROPERTIES

TEMPERATURE	20°C	400°C	600°C
Density g/cm ³	8.1	8.0	7.9
Modulus of elasticity kN/mm ²	266	237	213
Thermal expansion ratio per °C		10.6x10 ⁻⁶	11.1x10 ⁻⁶
Specific heat J/kg per °C	420	510	600

Microstructure



Typical microstructure showing an extremely high amount of fine, well-dispersed carbides in a martensitic Fe-Co matrix. Total carbide content is approximately 25vol%. This sample is hardened at 1180°C and tempered 3x1h at 560°C, resulting in Vibenite® 290 with a hardness of 72 HRC.

Hardness and heat treatment

HARDNESS

As printed	49-52 HRC
Hardened	68-72 HRC
Soft annealed	42 HRC

VBN normally carries out the heat treatment on your behalf. You can, however, purchase untreated material and perform this procedure yourself. If so, ensure that you follow the instructions below:

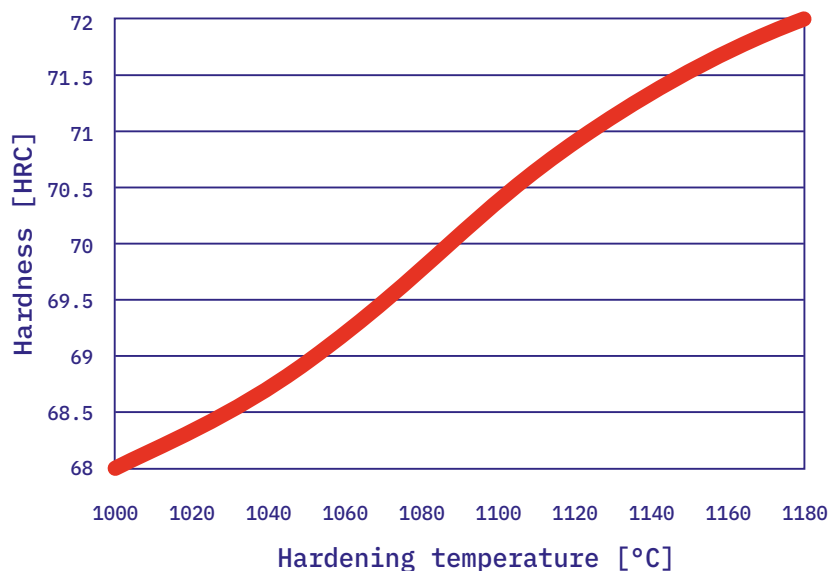
1. Heat the component to a temperature according to the curve below (allow +/- 1 HRC).
2. Cool to 25-50°C. Ensure a minimum cooling rate of 7°C/s between 1000°C and 800°C.
3. Temper at 560°C three times for at least 1 h each time.
4. Cool to room temperature (25°C) between temperings.

It is also possible to soft anneal the material and achieve a hardness of approximately 42 HRC. To soft anneal,

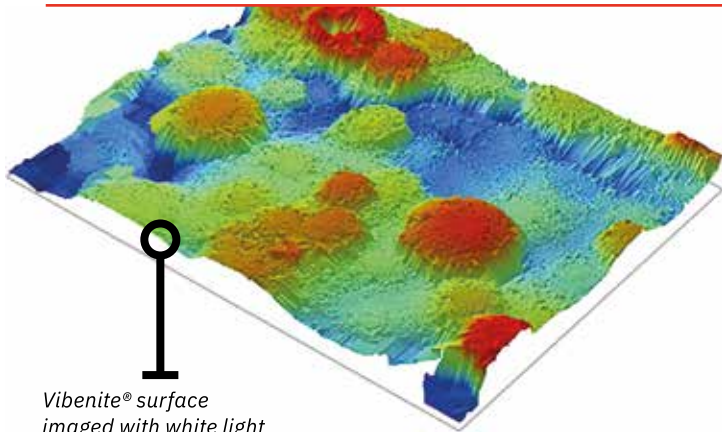
heat the component to 850-900°C and maintain this temperature for at least 3 hours. Then cool slowly at 10°C/h down to 700°C before letting the component air cool. The soft-annealed material is a very neutral material with primary carbides.

Note: A hardness of 72 HRC is approximately 1070-1130 HV depending on the measuring method and conversion type.

Also note that the hardness achieved is only converted into an approximate HRC value because it is so high that it is not possible to measure with a Rockwell indenter. The VBN hardness achieved is measured with Vickers indentation at 2 kg, i.e. HV 2 kg.



Hardness at different hardening temperatures and tempering 3×1 hour at 560°C.



Vibenite® surface imaged with white light optical profilometry.

Yield strength, $R_{c0.2}$

Vibenite® 290 belongs to the extremely hard material type that typically has no yield. These materials normally break directly without ductility when the maximum load has been reached, typically in proportion to the actual hardness. Nevertheless, the maximum load before Vibenite® 290 breaks is very high: 72 HRC. Vibenite® 290 has a yield strength of approximately 4300 MPa.

Information to the toolmaker:

The material will swell uniformly by about 0.14% during hardening.

3D printed surface and grinding

The Vibenite® 3D printed surface results from molten metal powders. This means that all surfaces demanding a high level of smoothness need to be ground. Furthermore, to achieve the desired surface after grinding, the drawing requires an add-on. If you need help with this

procedure, please contact VBN. For typical standard surfaces with normal tolerance needs, an add-on of 0.5 mm is sufficient. For high-load applications such as metal cutting tools, we recommend starting by adding 0.75 mm grinding allowance to the drawing. This allowance covers printing form errors and potential small geometrical changes due to hardening. Surfaces without tolerance demands do not need a grinding allowance addition.

There are many different post-treatment techniques that can highly reduce surface roughness. Contact VBN for more information.

Coating

The Vibenite® 290 alloy is also very suitable for preceding PVD coatings where the high Vibenite® substrate hardness results in a perfect combination with the even harder coatings. The high heat resistance in Vibenite® 290 is also beneficial.

Disclaimer

This material specification is only valid as a guideline without binding guarantees. The 3D printing process followed by hardening and eventual grinding must be well controlled. If you would like further information or assistance, please feel free to contact us.

Vibenite® 290 is a patented product from VBN Components AB.

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