

VBN Components AB

Vibenite®
Redefining wear resistance

3D printed metals with unique
wear resistance

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VBN
COMPONENTS

Materials development for additive manufacturing



Development of NEW METAL MATERIALS and PROCESSES for suitable 3D-printing methods.

Commercialization of wear resistant components made with Vibenite® materials.

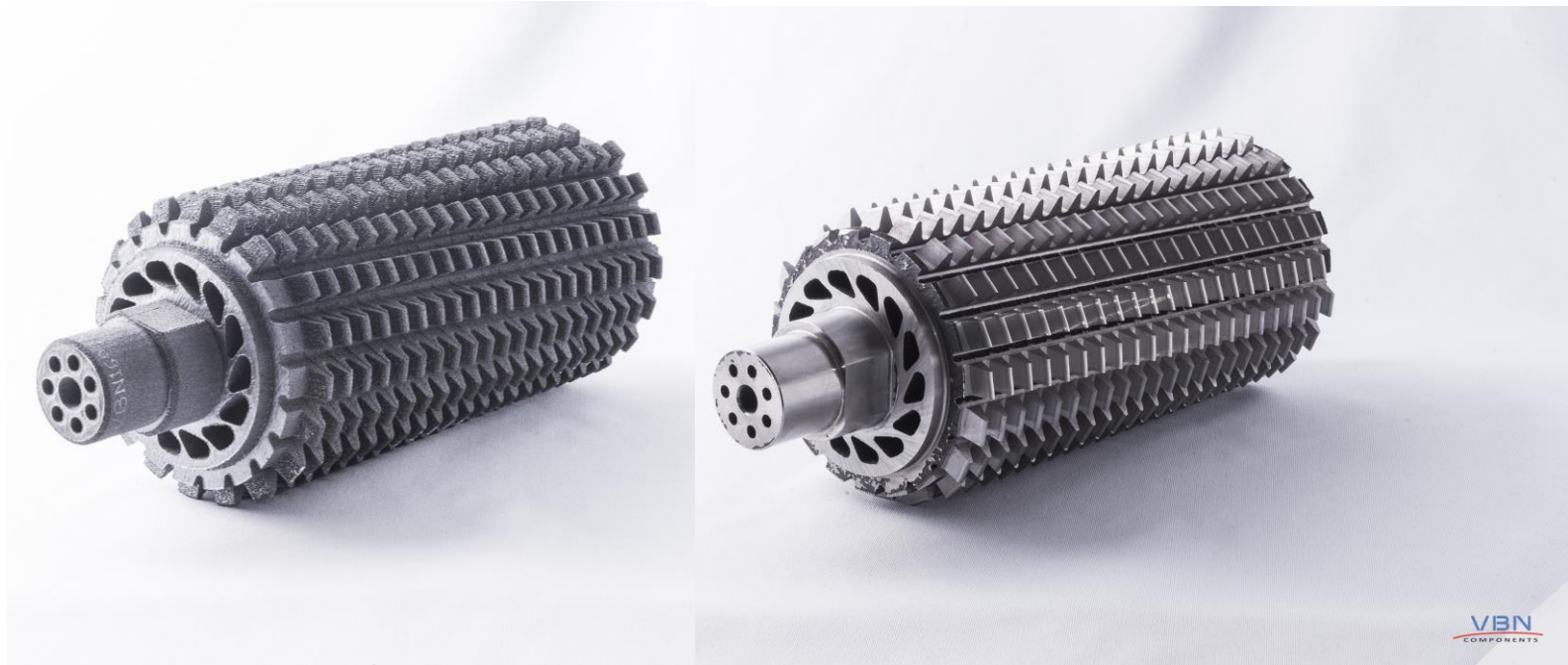
Manufacturing according to customer CAD-drawing of:

- A) hardened near-net-shape blanks
- or
- B) finished components (by grinding or edm)

Max size: 200 x 200 x approx. 380 mm (today).



Gear cutting hob in Vibenite® 280 -before and after grindning



The Vibenite® material group



New

Vibenite® 480

Hybrid carbide metal
~65% carbides
Hardness of ~66 HRC

2017

Vibenite® 290

World's hardest steel
~25% carbides
Hardness of 68-72 HRC

2013

Vibenite® 280

~20% carbides
Hardness of 63-70 HRC

2017

Vibenite® 350

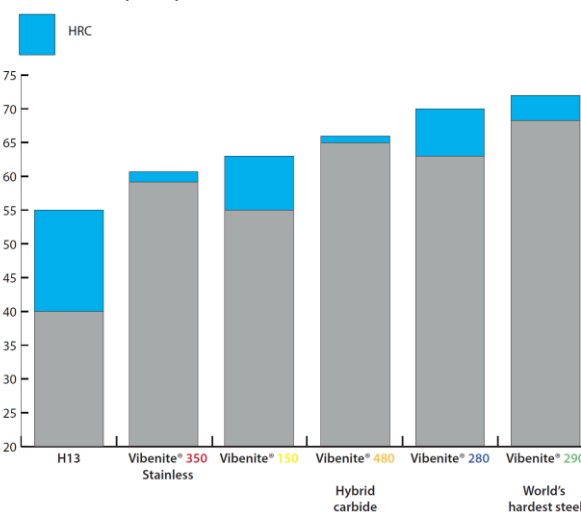
Corrosion resistant
~20% carbides and nitrides
Hardness of ~60 HRC

2016

Vibenite® 150

~7% carbides
Hardness of 55-63 HRC

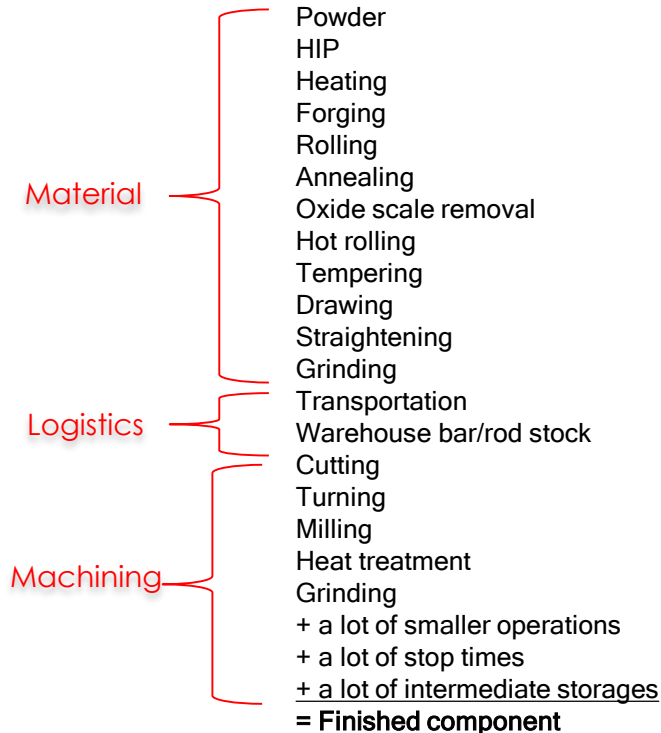
Hardness (HRC)



Why 3D-printing of wear resistant metals?



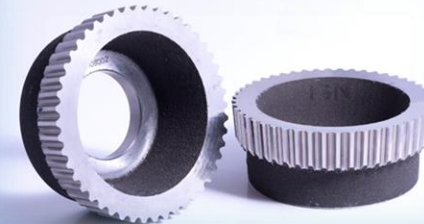
Traditional manufacturing



VBN Components manufacturing

Powder
Additive manufacturing
Heat treatment
Grinding

= Finished component



Shaper cutter in
Vibenite® 280 Optimum 70

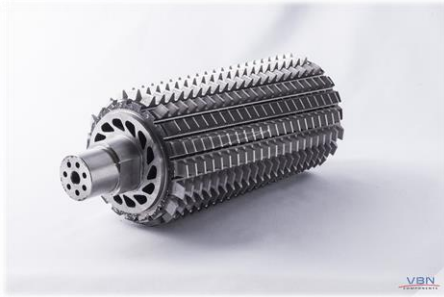
Materials with hardness and wear resistance



- **Vibenate® 350** - Stainless for plastic processing tools, pumps, rings, valves, etc.
- **Vibenate® 150** - Tough alloy for functional prototypes, tools, etc.
- **Vibenate® 480** - Hybrid carbide (cemented carbide) with ~65% carbide content. Hard, heat and wear resistant.
- **Vibenate® 280** - Metal cutting tools, wear protection, fatigue resistance, etc. Excellent combination of high hardness and toughness.
- **Vibenate® 290** - *The world's hardest steel*, for metal cutting tools, dry machining tools, etc.



Application examples



Metal cutting tools



Tools for food industry



Drills

Erosion components
Pumps, valves, seats
Wood working tools
High performance components
Plastic Processing Tools
High temperature wear
etc

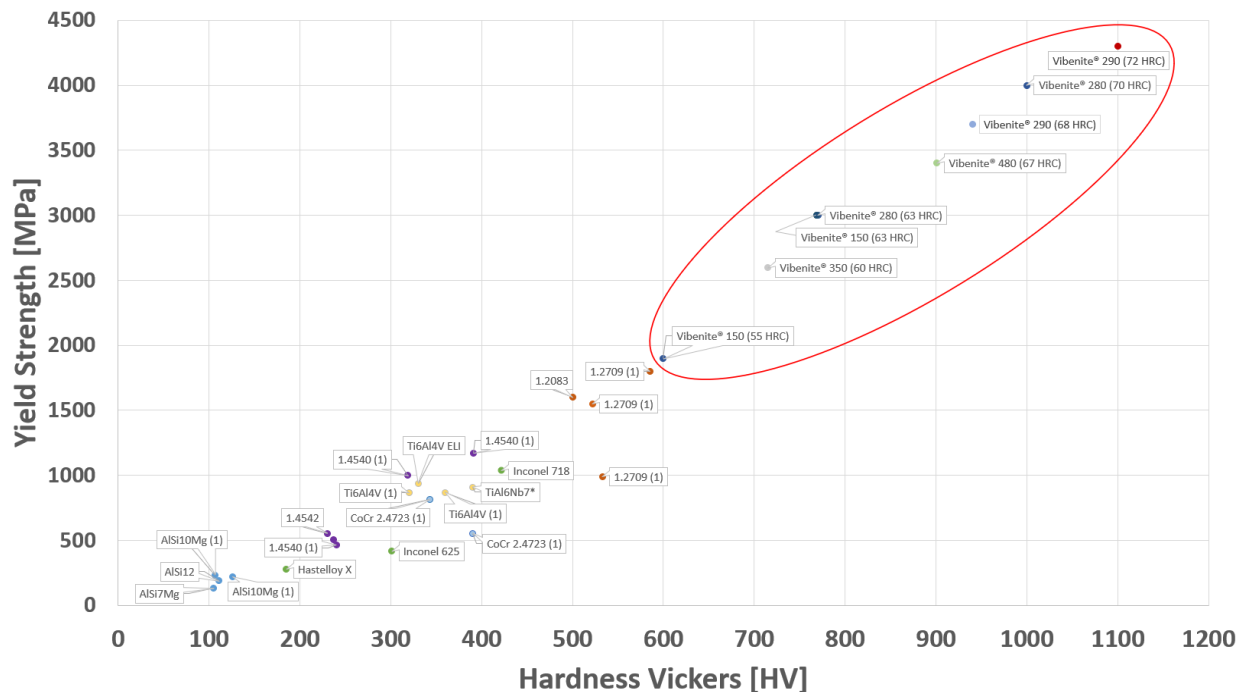


Engine components



Mining and rock drilling tools

Vibenite® in comparison with other additively manufactured materials



Vibenite® is in its own division of hard materials. It is the only AM material with carbide content.

Source: EPMA 2017, 2nd ed, Introduction to Additive Manufacturing Technology, sec 3.4.1 [Hardness and Yield strength for various materials produced by powder bed additive manufacturing technologies (Courtesy of Fraunhofer IFAM)], "(1)"=different manufactures; VBN Components AB 2018.

VCN Components offers



Pre-study

Is Vibenite® the perfect choice for the application?
Wear analysis
Technical discussions
Drawing
First test product
Visit in Uppsala, Sweden

Several test builds
Adjust building parameters
Optimal build file

Production development project

AM utilise study

Optimization of the function
with the help of AM-technology

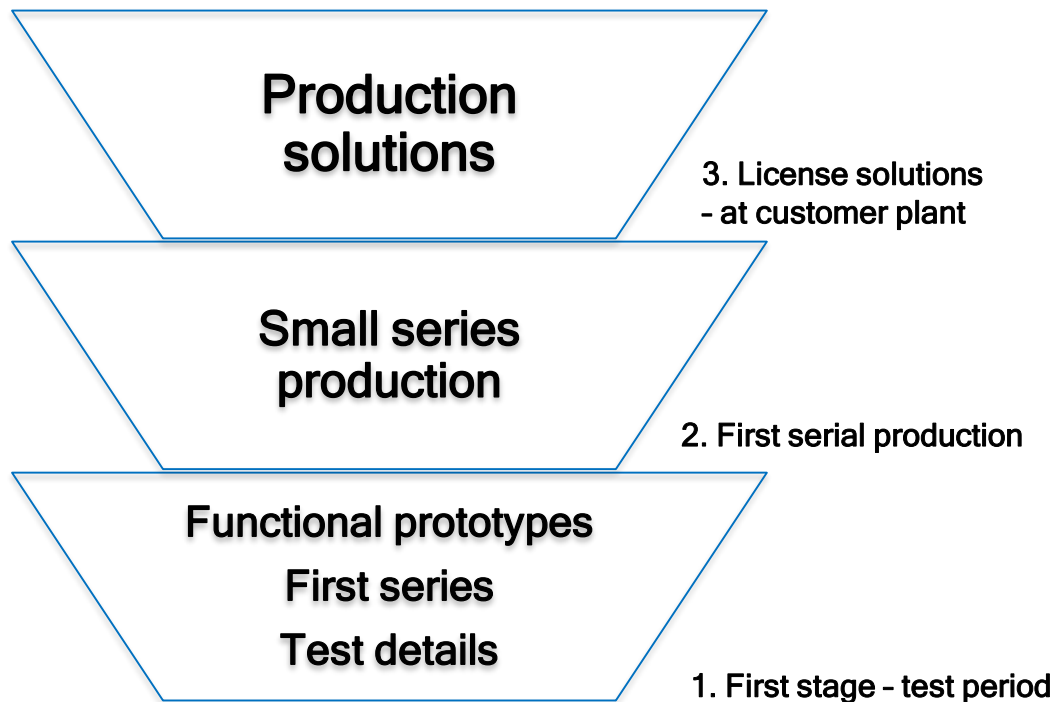
First serial production
If customer cannot produce

Small serial
production -
Serial production
at VCN

License solution –
Serial production
at customer

Settings for production
Machine recommendations
IP rights
Powders

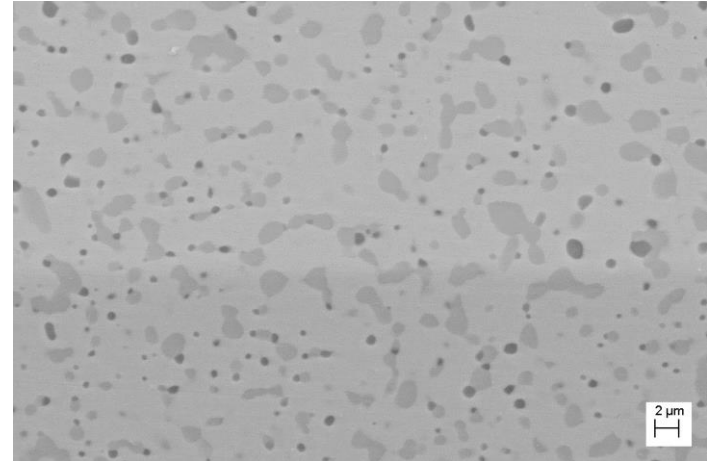
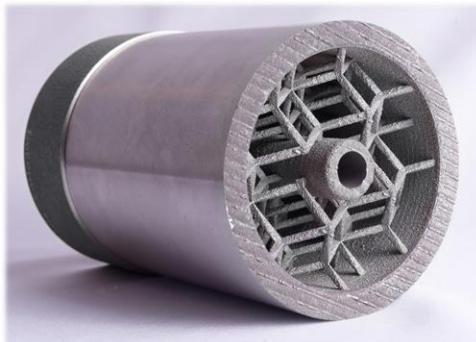
VCN business model



Vibenite® 350



- Very wear resistant and stainless material. ~60 HRC.
- Fine microstructure with fine carbides in a chromium rich martensitic stainless matrix => excellent properties.
- Developed with support from the Swedish Energy Agency => large energy and material savings.
- Applications: Valves, pumps, turbines, marine applications, plastic processing tools, etc.



Microstructure (hardened)

C	Cr	Mo	V	Fe
1.9	20	1.0	4.0	Bal

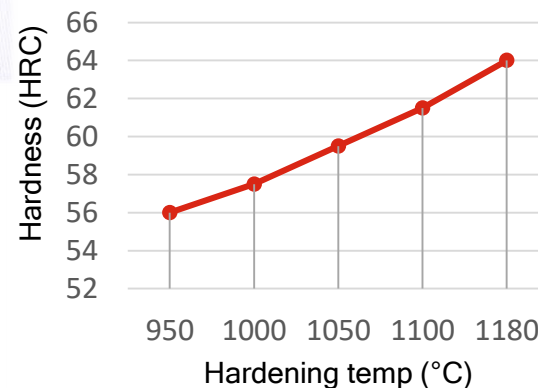
Composition

Vibenite® 150

- High performance, wear resistant Multi-Purpose material.
- Hardness 55 - 64 HRC.
- Fine microstructure with fine and wear resistant carbides -> unique combination of toughness and wear resistance.
- Functional prototypes, tool holders, cold work applications

C	Cr	Mo	W	V	Fe
1.5	4.0	2.5	2.5	4.0	Bal

Composition



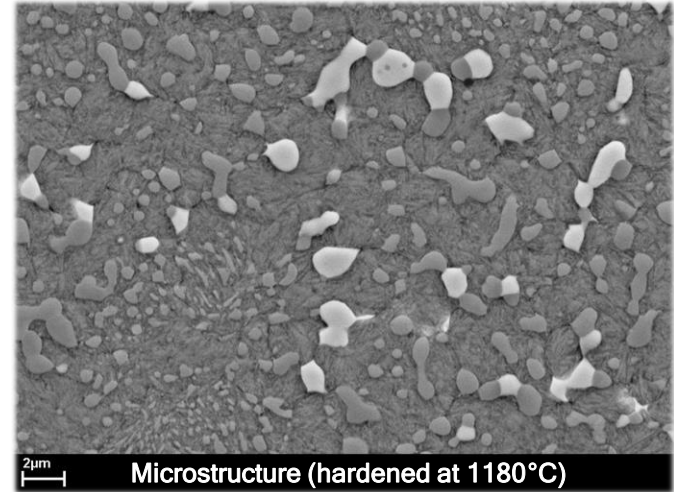
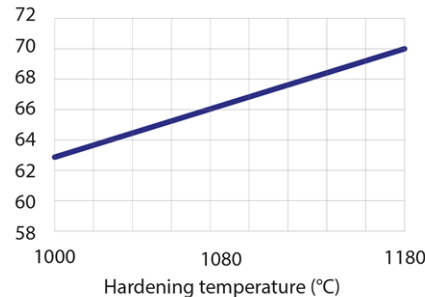
Vibenite® 280



- High strength, high hardness and very high wear resistance.
- Fine microstructure with high volume of fine carbides => high toughness.
- High hot hardness and uniformity.
- Wear parts and cutting tools such as gear hobs, broaches, cutters, etc.

Hardness HRC ⁽¹⁾	63-70 HRC
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⁽¹⁾ = Depends on hardening temperature, see graph.

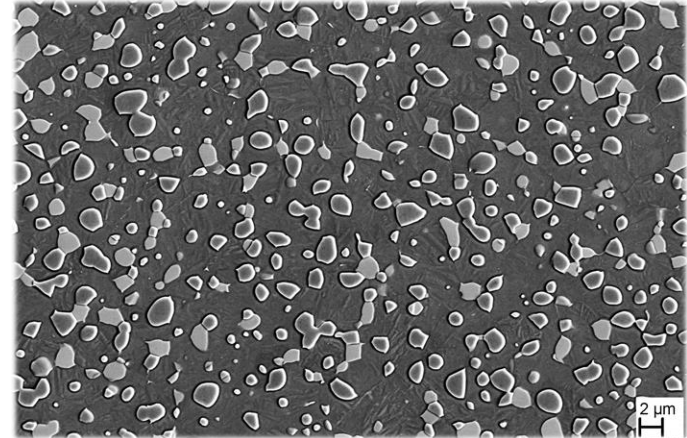


Fe	C	Cr	Mo	W	Co	V
Bal.	2,30	4,2	7,0	6,5	10,5	6,5
Composition						

Vibenite® 290



- The world's hardest commercially available steel grade.
Released November 2017. Possible to harden 68-72 HRC.
- Fine microstructure with high volume (~25vol%) of very fine carbides.
- Extremely high hot hardness and uniformity.
- Can replace cemented carbides in several applications.
- Wear parts and cutting tools such as gear hobs, broaches, shaper cutters, power skiving wheels, etc.



Microstructure (hardened at 1180°C)

Fe	C	Cr	Mo	W	Co	V
Bal.	2,50	4,0	5,0	11,2	16	6,3
Composition						

Vibenite® 480



In December 2018, VBN launched **Vibenite® 480**.

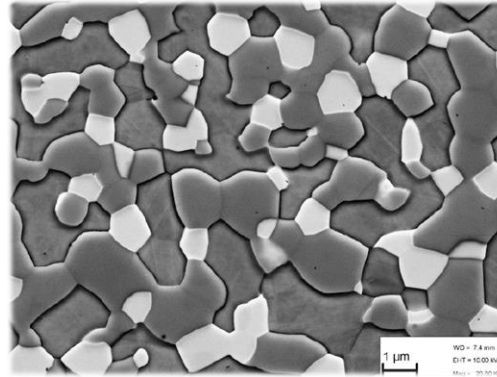
The world's first commercial, 3D printed cemented carbide (patented).

Hardness 800-900 HV with ~65% of carbides.

Extremely high production yield and wear resistance.

C	Cr	W	Co
3.6	20.5	22.5	Bal

Composition



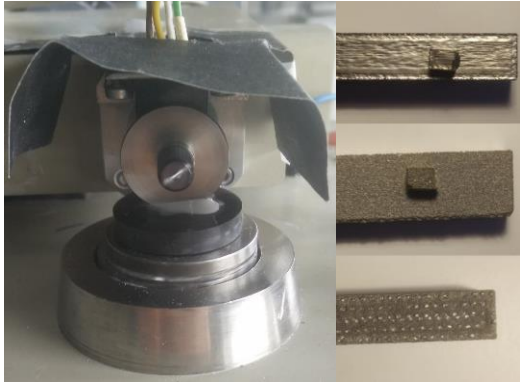
Microstructure

This new group of materials is called Hybrid Carbides, since it combines toughness from high speed steels and high hot hardness from carbides. It does not require binders and sintering and is therefore not “cemented”, which avoids typical limitations.



Abrasive resistance of Vibenite® 480

VBN

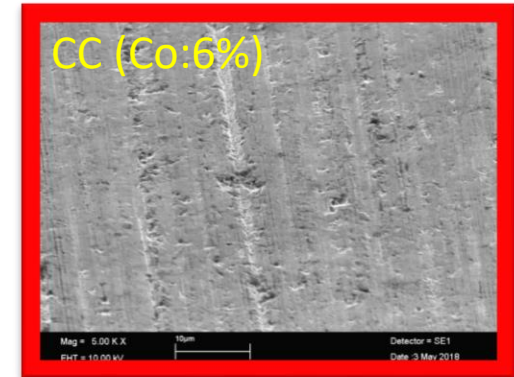


○ > ○ > ○ × 3
100 300 500

Abrasive test – dimple grinder
Diamond slurry, 2.5µm particles

Material	Measured hardness HV	Carbide content [%]	Wear volume 10 ⁻³ mm ³
Vibenite® 480	835	65	5.2
Cemented carbide 6% Co medium grain size	1490	94	7.1
Cemented carbide 25% Co medium grain size	955	75	9.8

- The test resulted in chipping wear of traditional cemented carbides.
- Extremely low wear rate of Vibenite® 480
- Hardness is not everything, the correct balance between abrasive particle type/size and material choice is important.

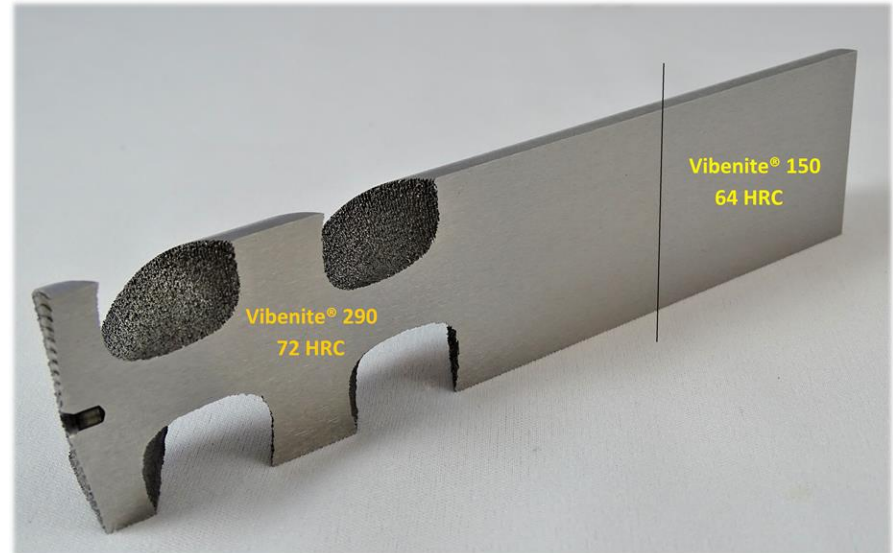


ABRASION RESISTANCE OF NEW WEAR RESISTANT AM STEELS BY P. SÖDERBÄCK, U. BESTE AND U. WIKLUND, Results presented at NORDTRIB 2018.

Vibenite® Combo



- Method developed in 2019.
- Combining different properties in the same component.
- Vibenite® 290 printed upon cylinder of Vibenite® 150.
- Toughness of Vibenite® 150 combined with the extreme hardness of Vibenite® 290, the world's hardest steel.
- Control of thermal expansions ensures pore- and crack-free weld.
- Many possibilities exists



Metal cutting

Comparison of Vibenite® 280 gear hob with standard competitor hob

Analyzed scenarios of gear-cutting tools at large Swedish manufacturer



Results of Life Cycle Cost Analysis (LCCA)
for gear cutting (20,000 units per year):

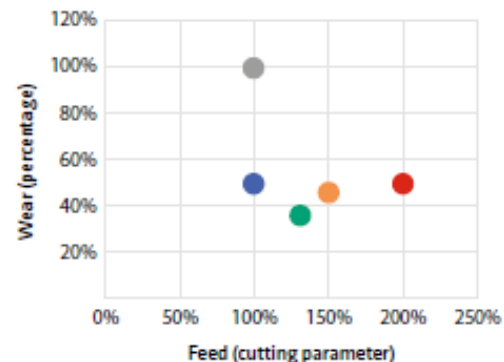
- Total production cost per produced gear reduced by 15-20% due to double lifetime of the Vibenite® tool.
- Double cutting feed cuts cost by an additional 15-20%.
- Total reduced production cost per produced gear = 30-40%.



CONCLUSION

Reduced production cost per
gear = 30-40%.

Wear of Vibenite® 280 compared with 22 reference tools. Gear-cutting application, wet hobbing.



- Reference tools, 22 pcs of top traditional material, 100% feed
- Vibenite® 280, 2 pcs, 100% feed
- Vibenite® 280, 2 pcs, 130% feed
- Vibenite® 280, 2 pcs, 150% feed
- Vibenite® 280, 2 pcs, 200% feed

Heavy material savings on gear hobs

Case calculated on Vibenite® 280 (before launching Vibenite® 290 and 480).



	Yield traditional manufacturing	Yield VBN Additive Manufacturing
Manufacturing of steel bar	~70%	-
Manufacturing of hob blank	~50%	~98%
Total material yield manufacturing	~35%	~98%

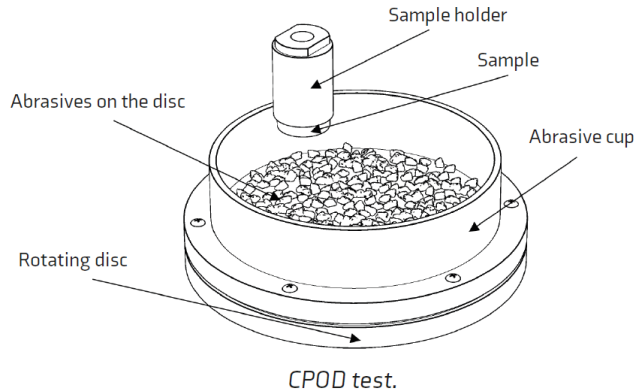
	Traditional manufacturing	VBN Additive manufacturing
Yield manufacturing	35%	98%
Performance (feed)	100%	200%
Weight hob	15.3 kg	11.2 kg
Number of produced gears/gear hobs	7150 pc.	14300 pc.
Hob material consumption per produced gear (HMCPPG)	6.1 g	0.80 g

=> 87% material savings!

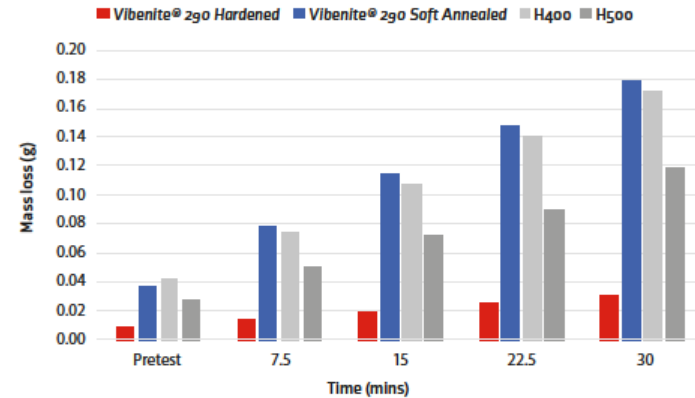
- The first grinding removes more material from the 3D-printed part, but the following grindings are the same.
- The material savings on coatings are not included.
- The traditional example is calculated for a steel bar close in dimension, but typically larger bars are used with more material removed.

Vibenate® 290 against rock

CPOD (Crushing Pin On Disc), Kuru granite, Abrasion.



Abrasive size [mm]	Mass fraction [g]
8 / 10	50
6.3 / 8	150
4 / 6.3	250
2 / 4	50
Total	500

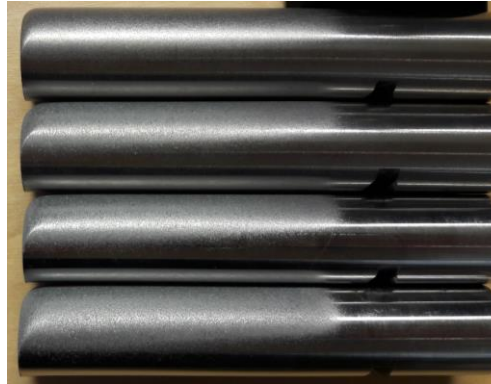
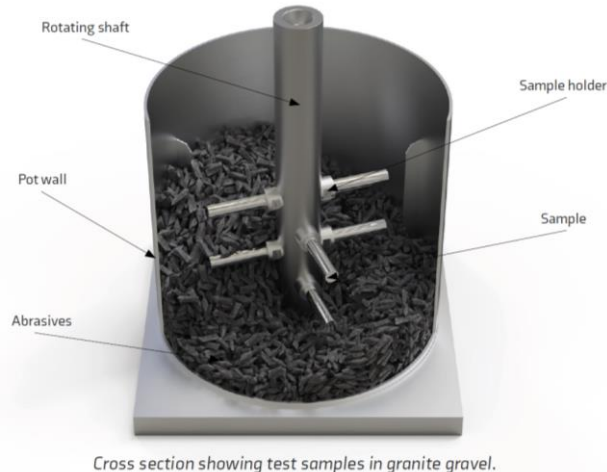


Four materials in CPOD test – wear rate in grams as a function of time in minutes.

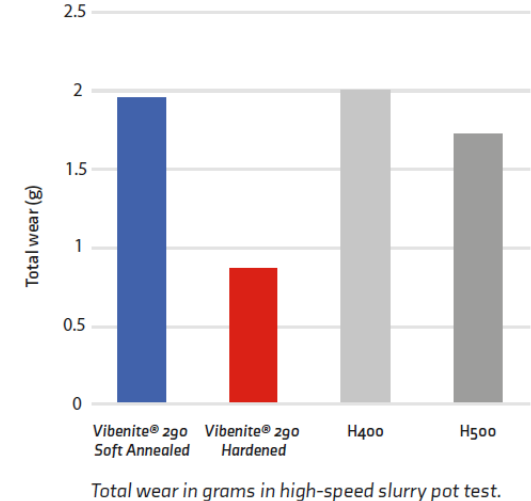
- The CPOD method is very tough for hard materials such as Vibenate® 290, since it will expose them to two-body abrasion, which abrades more than three-body abrasion.
- Still, hardened Vibenate® 290 is only worn 25% compared to the closest competitor.
- No chipping or cracks could be seen for Vibenate® 290.

Vibenite® 290, High Speed Slurry Pot Test

Kuru granite, no water. Erosion/abrasion against rock.



1000 rpm -> 10m/s at tip, 20 min. test time,
pin position switched each 5 min. 2 tests.



- The hardened Vibenite® 290 is worn only 50% compared to the closest competitor.
- No chipping or cracks could be seen.

A large number of Customer benefits



- No forging, no rolling, no machining
- Possible to use extremely wear resistant materials without limitations
- Rapid product development
- New functions through intelligent geometries
- Reduced production cost with Vibenite® performance
- Heavily reduced environmental impact
- Small or large series
- Minimized material stock
- Spare parts of your choice



Get more information

YouTube:

There are also links to the films on www.vbncomponents.com



Vibenite® 480: A new type of cemented carbide



World's hardest steel - made in Uppsala, Sweden