VBN Components AB

Vibenite®

Redefining wear resistance

New materials through additive manufacturing

Additive Manufacturing in nuclear energy applications at Energiforsk – Webinar 2020-09-23

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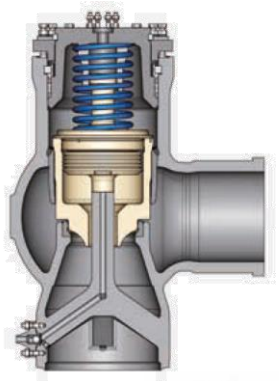
VBN COMPONENTS

What can VBN do for the nuclear sector?

- VBN can deliver parts in near-net-shape that requires no machining, which lead to huge material savings, e.g:
  - Valve houses, valve rings, impellers.
  - Wear parts
- Vibenite® has very good hardness and toughness compared to other alloys, which extends operational lifetime. VBN can for example provide the world's hardest steel with a hardness of ~72 HRC.
- Complex shapes, cooling channels, and other features are often not a problem. For example, it is possible to provide holes for sensors close to a working zone.
- Short delivery times of spare parts during revisions and unplanned maintenance.
- License solutions available for manufacturers that wants to do manufacturing inhouse.

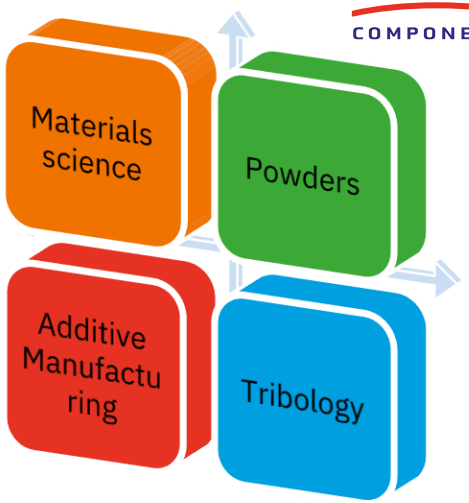


Cost savings

- Proven material savings with 90% thanks to the Vibenite® Additive Manufacturing technique.
- Highly improved productivity at end user thanks to better wear and heat resistance, and smarter detail design.
- No machining and less process steps thanks to the near-net-shape deliveries. And this in very difficult-to-process materials.
- Turn-around time for prototyping is extremely fast.

What is VBN Components?

- A materials developing company
- Deep knowledge in materials science
- Wide experience in powder manufacturing
- Extensive research in tribology*
- AM** production unit in Uppsala, Sweden
- >10 years in additive manufacturing



** = The Science of wear and friction of materials*
*** AM = Additive Manufacturing = 3D-printing = Additiv Tillverkning = Free forming*

Winner of:

BONA POSTULATA PRISET 2014

STIFTELSEN SKAPA
Det svenska innovationspriset
In memory of **Alfred Nobel**

VINNARE ÅRETS INNOVATION UPPSALA 2018

SPD AGS Innovation Award 2018

MM Maschinenmarkt
Innovation Award 2019

TCT Materials Award
Highly Commended 2019

WINNER BEST OF INDUSTRY AWARD **Germany 2020**

Materials development for AM

VBN works with development of NEW METAL MATERIALS and PROCESSES for suitable Additive Manufacturing (AM) methods.

Commercialization of hard and wear resistant components made with Vibenite® materials.

VBN is today using Electron Beam Melting (EBM).

Manufacturing according to customer CAD-drawing of:

A) hardened near-net-shape blanks

or

B) finished components (by grinding or edm at subcontractor)

Max printing size: 230 x 230 x approx. 380 mm (today).

Why 3D printing of wear resistant metals?

Traditional manufacturing

Material
- Powder
- HIP
- Heating
- Forging
- Rolling
- Annealing
- Oxide scale removal
- Hot rolling
- Tempering
- Drawing
- Straightening
- Grinding

Logistics
- Transportation
- Warehouse bar/rod stock
- Cutting

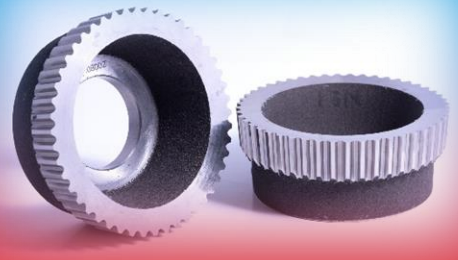
Machining
- Turning
- Milling
- Heat treatment
- Grinding
- + a lot of smaller operations
- + a lot of stop times
- + a lot of intermediate storages

= Finished component

VBN Components manufacturing

Powder
Additive manufacturing
Heat treatment
Grinding

= Finished component



Shaper cutter in Vibenite® 280 Optimum 70

The Vibenite® material group

Patented materials
High hardness – wear resistance – high strength - corrosion resistance - toughness – fatigue resistance

VIBENITE® 480
Hybrid carbide metal
~65% carbides
Hardness of ~66 HRC

VIBENITE® 290
World's hardest steel
~25% carbides
Hardness of 68-72 HRC

VIBENITE® 280
High speed steel
~20% carbides
Hardness of 66-70 HRC

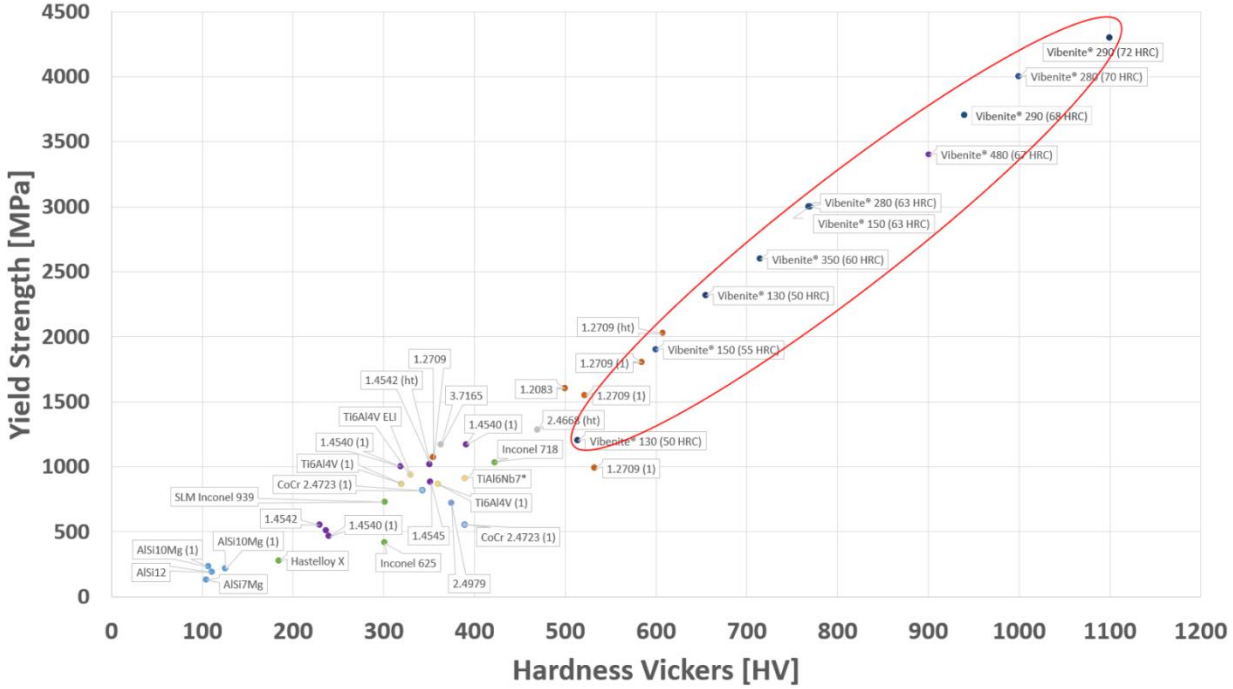
VIBENITE® 350
Corrosion resistant steel
~20% carbides and nitrides
Hardness of ~60 HRC

VIBENITE® 150
High speed steel
~7% carbides
Hardness of 55-63 HRC

Coming soon...

VIBENITE® 130
Tool steel
~2% carbides
Hardness of 48-60 HRC

Vibenite® v/s other AM materials



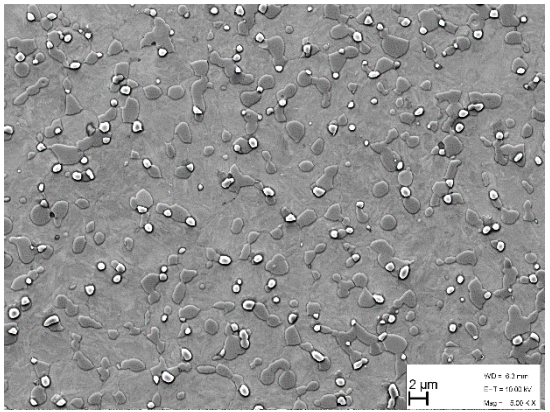
Source: EPMA 2015 (1st ed), 2017 (2nd ed), 2019 (3rd ed), Introduction to Additive Manufacturing Technology, sec 3.4.1 [Hardness and Yield strength for various materials produced by powder bed additive manufacturing technologies (Courtesy of Fraunhofer IFAM)], "(1)"=different manufacures. "(ht)"=heat treated; VBN Components AB 2019/2020.

Vibenite® is in its own division of hard materials.

It is the only AM material with carbide content.

Vibenite® 350

Suitable for nuclear applications



Microstructure (hardened)

Swedish Energy Agency

- Wear resistant and corrosion resistant material. ~60 HRC.
- Fine microstructure with fine carbides in a chromium rich martensitic stainless matrix => excellent properties.
- High cleanliness (low oxygen content).
- Developed with support from the Swedish Energy Agency => large energy and material savings.

- Applications: Valves, pumps, turbines, marine applications, plastic processing tools, etc.
- Cobalt free alloy - suitable for nuclear applications.

C	Cr	Mo	V	Fe
1.9	20	1.0	4.0	Bal

Composition

Vibenite® 150

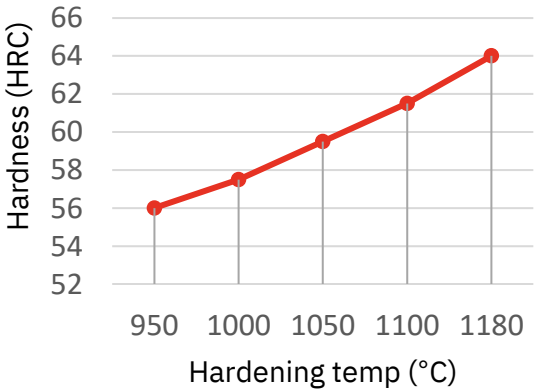
High performance, wear resistant multi-purpose material.

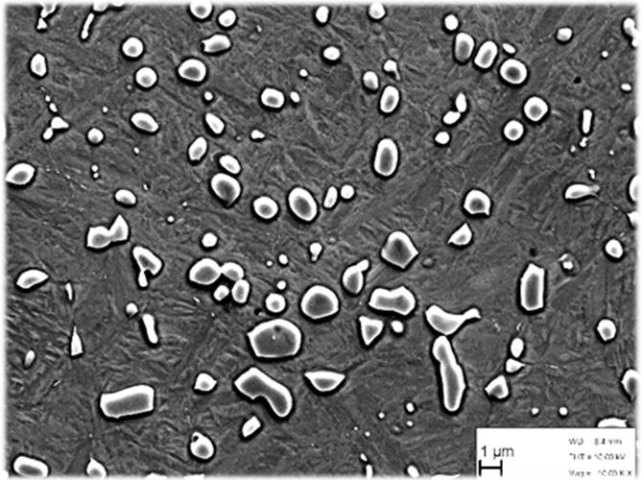
Very high fatigue resistance.

Hardness 55–64 HRC.

Fine microstructure with fine and wear resistant carbides -> unique combination of toughness and wear resistance.

Hot stamping tools, casting tools, functional prototypes, tool holders, cold work applications



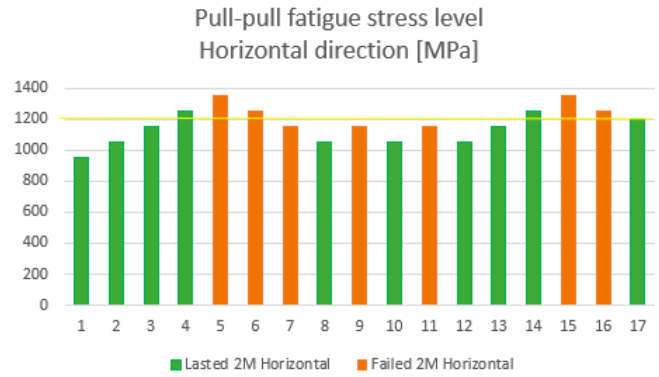


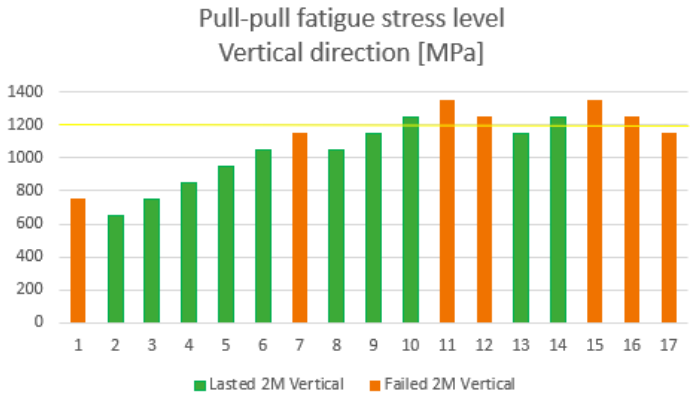
Microstructure

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

Composition

Performance: Fatigue resistance of Vibenite® 150





- Pull-pull fatigue testing, staircase method.
- Load pulsating from 10% to 100% of chosen start load.
- Max cycle number: 2,000,000 cycles (2M).
- The test sample is a standard cylindrical sample with a waist of Ø6 mm.
- Vibenite® 150 hardened to 59 HRC (674 HV10)

RESULTS:

*** Very high fatigue stress level: ~1200 MPa**

*** Uniform fatigue level in vertical and horizontal 3D print direction**

Vibenite® 290

The world's hardest commercially available steel grade. Released in November 2017.

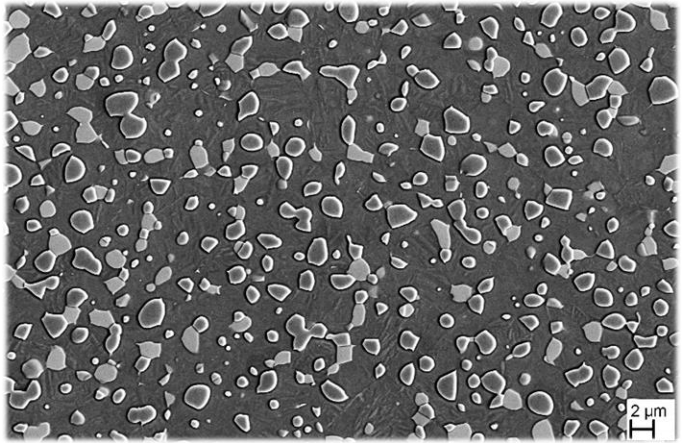
Possible to harden 68–72 HRC.

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, 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

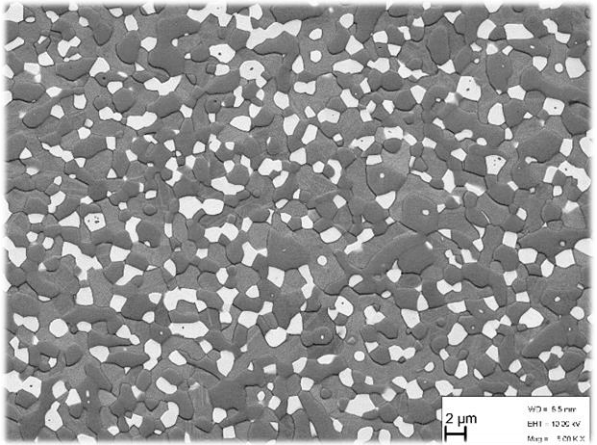
The world's first commercial, 3D printed cemented carbide (patented).

Hardness of ~67 HRC.

Carbide content: ~65%.

Extremely high hot hardness.

High wear resistance.



Microstructure

The first alloy in a new group of materials called Hybrid Carbides.

Combines toughness from high speed steels and high hot hardness from carbides.

Does not require binders and sintering and is therefore not "cemented".

Composition

C	Cr	W	Co
3.6	20.5	22.5	Bal

Benefits – example

Highly increased life time, thanks to patented metal cleanliness.
Smarter design
No porosity
High hardness

Increased end performance

Advanced customer support

Short prototyping time
Expertise in materials and wear
Expertise in powders and AM
Expertise in AM design

Component:
Roller bearing rings

Production simplification

Near net Shape delivery
No machining from solid bars
Large diameters or small diameters
No bar stock
Shorter delivery times
Less process steps

Environmentally friendly

90% reduction of material
2/3 reduction of energy
Less heavy transports
Quick development to better products

VBN Components' customer offer

Pre-study Standard

Simple technical discussions
Drawings, first test product.
Visit in Uppsala, Sweden.
Result: Does it work technically?

Pre-study Advanced

Is Vibenite® the perfect choice for the application? Analysis of existing detail problem - deeper discussions. A number of test products. Visit in Uppsala. **Result:** Does it work technically?

Pre-study AM utilize

Optimization of the function with the help of AM-technology.
Result: Enhanced performance by geometry, cooling, support, lightweight...

Production development project

Several test builds + adjustment of building parameters + optimal build file
Result: How much will it cost in large series production?

Direct print

Direct print for a customer who has a finished drawing and knows what material to print.

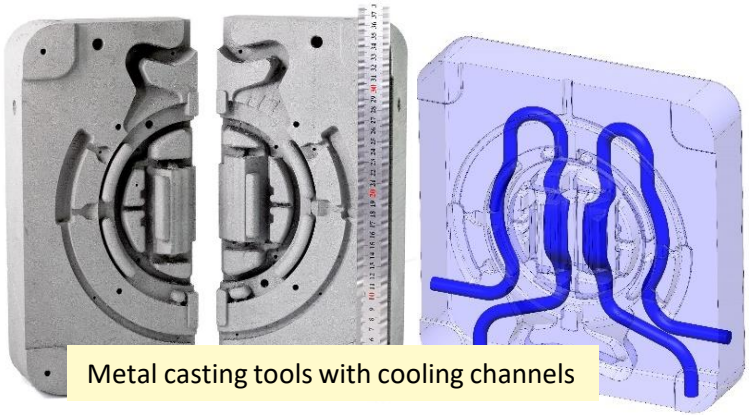
Small serial production at VBN

If you cannot have, or do not want your own production.

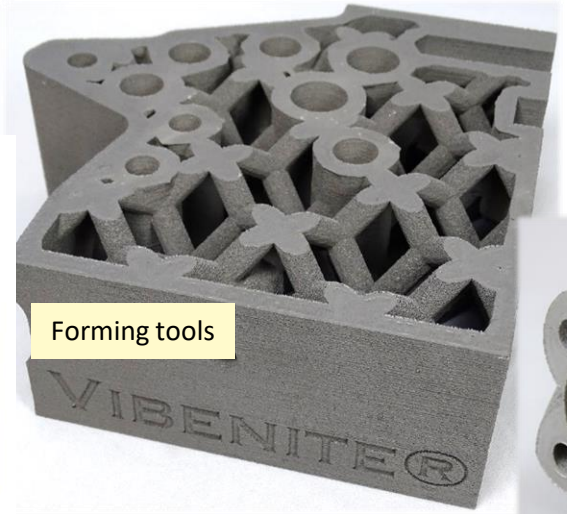
License solution – Large serial production at customer

Large serial production at your site. AM-settings for production. Machine recommendations, IP rights, powders.

Examples



Metal casting tools with cooling channels

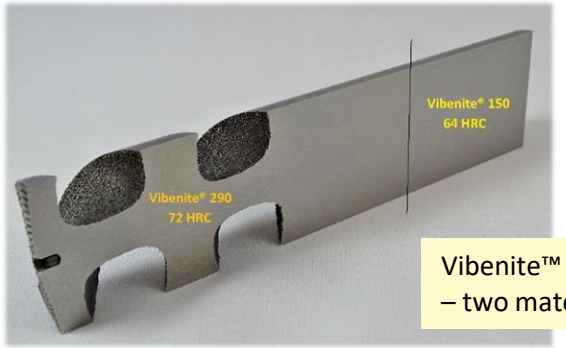


Forming tools

Screws with cooling channels

Lightweight metal cutting tools

Food extruder



Vibenite™ Combo
– two materials combined

Thank you!

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