AGENDA

TITANIUM POWDER BY SANDVIK – THE ADDITIVE ADVANTAGE

13:30 - 13:45	SAFETY FIRST AND WELCOME!	Kristian Egeberg
13:45 - 14:10	INTRODUCTION TO SANDVIK – AND TITANIUM AS AN ELEMENT	Mikael Schuisky
14:10 - 14:35	TITANIUM AND NICKEL POWDER PRODUCTION BY SANDVIK	Martin Mueller
14:35 - 15:00	TITAINUM AND NICKEL POWDER BY SANDVIK – THE ADDITIVE ADVANTAGE	Keith Murray
15:00 - 15:20	SWEDISH "FIKA"	All
15:20 - 15:40	AM-PROCESSING OF TITANIUM	Harald Kissel
15:40 - 16:10	BEAMIT – EXPERIENCE FROM AM OF TITANIUM COMPONENTS	Michele Antolotti and Martina Riccio
16:10 - 16:25	TITANIUM COMPONENTS FOR GSD E-BIKES	Zach Krapfl
16:25 - 16:40	LIGHTWEIGHT COROMILL [®] 390	Matts Westin
16:40 - 16:55	OSSDSIGN – IMPLANTS FOR BONE REGENERATION	Kajsa Björklund
16:55 - 17:10	SWISS CENTER OF MANUF. TECHNOLOGIES FOR MEDICAL	Harald Kissel
17:10 - 17:30	SUMMARY, CONLCLUSIONS AND KEY TAKE-AWAYS	Mikael Schuisky & All
18:00	DINNER @ BRUKSMÄSSEN	All

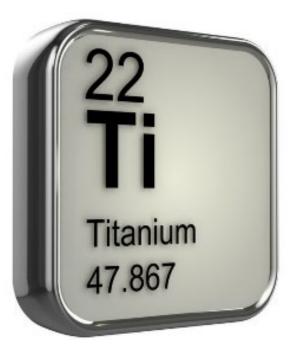


ADDITIVE MANUFACTURING OF TITANIUM SANDVIK ADDITIVE MANUFACTURING



HARALD KISSEL R&D MANAGER SANDVIK ADDITIVE MANUFACTURING

TOP 8 USES OF TITANIUM POWDER FOR ADDITIVE MANUFACTURING IN 2018



1. Medical	33%
2. Aerospace	27%
3. Service bureaus	17%
4. Dental	3%
5. Automotive	3%
6. Oil & Gas	2%
7. Energy	2%
8. Other	13%





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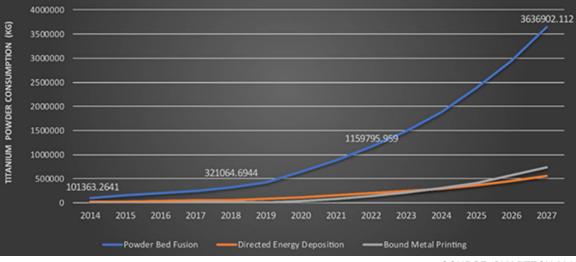






TITANIIUM AM POWDER CONSUMPTION BY PRINT TECHNOLOGY FAMILY

Total Projected Titanium AM Powder Consumption by Print Technology Family, Global, 2014-2027(e)



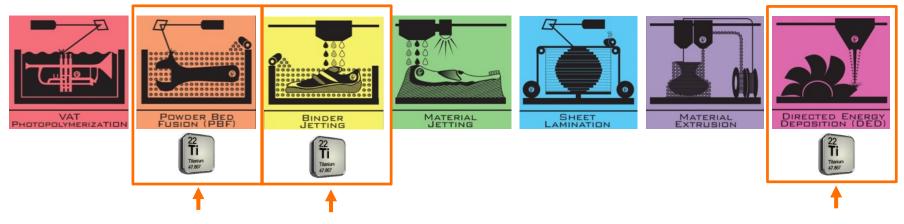
- Powder Bed Fusion

- Direct Energy Deposition
- Bound Metal Printing





7 FAMILIES OF ADDITIVE MANUFACTURING METAL AM PROCESSES IS UNDER DEVELOPMENT FOR ALL



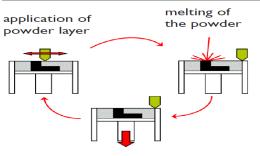
At present only three have proven to be able to build in titanium, as far as we know.



POWDER BED FUSION

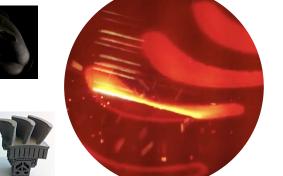
PBF Ebeam (2003) Titanium process
PBF Laser (199X) Titanium process

METALS AND POLYMERS

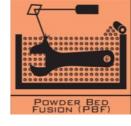


lowering the platform

- Melting technology
- Used for both polymer and metals
- PBF Laser or Ebeam
- Powder Bed
- Protective atmosphere or vacuum
- Build speeds 5-100 cm³/h
- Support structures needed







POWDER BED FUSION

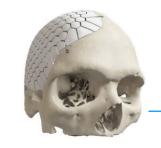


LASER

- The PBF laser process is a well established AM technology for Titanium.
- Initially adopted by medical and aerospace industries, but in recent years also by sports, motorsports and tooling applications.





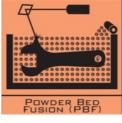


COURTESY OF OSS DSIGN





POWDER BED FUSION



EBEAM

• The EBM process develop by Arcam in 2003 is a well established AM technology for Titanium but also TiAl, mainly adopted by medical and aerospace industries.



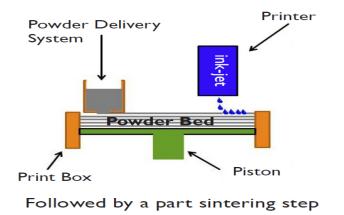




BINDER JETTING



IN PRINCIPLE ANY POWDER (METALS, CERAMICS, POLYMERS)



- Powder bed
- Binder technology
- No need for support structure
- Broad material range from sand to pure metals
- Post process sintering
- Build speeds up to 8200 cm3/hr

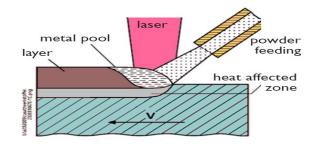
→ Digital Metal is the only Binder Jet System supplier offering Ti6Al4V (Grade 5) today.



DIRECT ENERGY DEPOSITION



IN PRINCIPLE ANY POWDER (METALS, CERAMICS, POLYMERS)



- Laser or Ebeam
- Powder or Wire
- Larger components
- Multi material possibilities
- Hybrid solutions



→ DED (LAM) Titanium process developed in 1997.



OUR LEARNINGS FROM LIGHTWEIGHT COROMILL® 390

MANUFACTURING PROCESS FOR LIGHTWEIGHT COROMILL® 390

PRINT TECHNOLOGY:

• Printing in Powder Bed Fusion - Laser (RenAM500Q)

POST PROCESSING

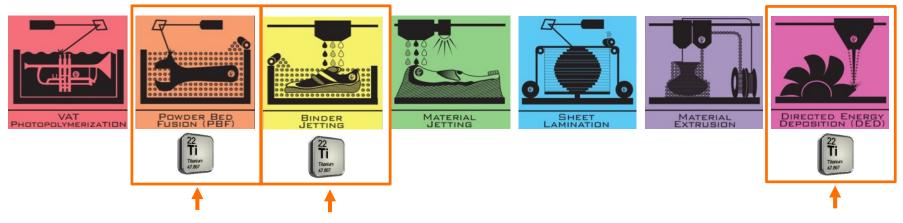
- Heat treatment for stress relief
- Wire EDM to remove from build plate
- Removal of support structure
- Grinding on belt grinder to remove burr
- Turning, milling, drilling and threading of outer surface insert pockets, screw holes etc.
- Blasting
- Nitration is done mainly for resistance against chip wear/chip erosion (it also makes the gold-like color)





SUMMARY AND DISCUSSION

WHAT ARE YOUR LEARNINGS FROM AM OF TITANIUM?



At present only three have proven to be able to build in titanium, as far as we know.

