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 BY SANDVIK WORLD LEADING OSPREY® METAL POWDERS

KEITH MURRAY VP AND HEAD OF GLOBAL SALES SANDVIK ADDITIVE MANUFACTURING



PERFECTING THE ADDITIVE VALUE CHAIN SINCE 1862...



LEADER IN METAL POWDER FOR AM

OSPREY™ METAL POWDERS

MORE THAN 2000 GRADES

FIRST YEAR OF POWDER SALES 1979

OUR PROGRAM OF OSPREY™ METAL POWDER INCLUDES:

- Low alloy steels
- Tool steels, incl. maraging steels
- Stainless steels, incl. Nickel-free
- Duplex steels
- High temperature materials
- Nickel-based superalloys
- Cobalt alloys
- Copper alloys
- Aluminum alloys
- Controlled expansion alloys
- Soft magnetic alloys
- Binary alloys
- Titanium alloys



POWDERS FOR AM PARTICLE SIZE CAPABILITIES FROM SANDVIK





OSPREY® TITANIUM EXPANDING OUR OFFERING

- Osprey[®] Ti-6AI-4V Grades 5 and 23 initially
- Particle Sizes suitable for:
 - Powder Bed Fusion (Laser & Electron Beam)
 - Direct Energy Deposition (DED)
 - Metal Injection Moulding (MIM)
- Future developments to include:
 - Commercially Pure Titanium
 - Higher Performance Alloys



	Osprey [®] Ti-6Al-4V Osprey [®] Ti-6A Grade 5* Grade 23*	
	(wt%)	(wt%)
Titanium	Balance	Balance
Aluminium	5.5-6.75	5.5-6.5
Vanadium	3.5-4.5	3.5-4.5
Iron	0.30 max	0.25 max
Oxygen	0.20 max	0.13 max
Carbon	0.08 max	0.08 max
Nitrogen	0.05 max	0.05 max
Hydrogen	0.015 max	0.012 max
Yttrium	0.005 max	0.005 max
Others, each	0.10 max	0.10 max
Others, total	0.40 max	0.40 max

*According to ASTM F2924-14 ** According to ASTM F3001-14



OSPREY® TI-6AL-4V GRADE 23: -63+20UM









OSPREY[®] TI-6AL-4V GRADE 23: -63+20UM











NICKEL-BASED SUPERALLOY POWDERS

- State-of-the-art atomising plant with melting under vacuum
 - Nitrogen and Argon capabilities
 - Powder with ultra low oxygen and nitrogen levels, typically below 250 ppm
- Dedicated downstream sieving, blending and packing facility
- High quality GA powders for Additive Manufacturing* and Hot Isostatic Pressing
- Osprey[®] materials: Alloy 625, Alloy 718 and H-X
 - Other alloys available on request
- ISO 9001 certified
- AS9100 certification targeted in 2019



IN718

Powders optimised for Powder Bed Fusion applications

- Ultra low Oxygen and Nitrogen levels, <250ppm
- Low levels of internal porosity
- Consistent particle size
 distribution and composition







OSPREY[®]

IN718

Powders optimised for Powder Bed Fusion applications

- Ultra low Oxygen and Nitrogen levels, <250ppm
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- Consistent particle size
 distribution and composition









OSPREY® ALLOY 718

MATERIAL PROPERITIES

- high mechanical strength in combination with high corrosion resistance
- Attractive mechanical properties at elevated temperatures up to ~650 °C

ADDITIVE PROCESSES

- Powder Bed Fusion, Laser
- Powder Bed Fusion, Electron Beam

TYPICAL USES/APPLICATIONS

- Jet turbines
- Gas turbines
- Oil and gas



OSPREY® ALLOY 718

POWDER BED FUSION - LASER (AS BUILT)

Parameter	Vertical Direction	ASTM F3055 14	Horizontal Direction
Yield Strength [MPa]	656	600	787
Tensile Strength [MPa]	934	920	1044
Elongation (%)	61	27	50
Impact toughness [J]	108	-	na

EOS M 290

POWDER BED FUSION – ELECTRON BEAM (AS BUILT)

Parameter	Vertical Direction	ASTM F3055 14	Horizontal Direction
Yield Strength [MPa]	980	600	860
Tensile Strength [MPa]	1210	920	1070
Elongation (%)	19	27	29
Impact toughness [J]	20	-	20



OSPREY[®] ALLOY 625

MATERIAL PROPERITIES

- Attractive mechanical strength in combination with excellent corrosion resistance, particularly good resistance to marine corrosion
- Performs well in ambient to elevated temperatures up to ~1000 °C related to rupture resistance, creep resistance, resistance to corrosive attacks

ADDITIVE PROCESSES

- Powder Bed Fusion, Laser
- Powder Bed Fusion, Electron Beam

TYPICAL USES/APPLICATIONS

- Critical corrosion resistant components
- Pressure vessels
- Chemical processing

OSPREY® ALLOY 625

POWDER BED FUSION – LASER (AS BUILT)			
Parameter	Vertical Direction	ASTM F3056 14a	Horizontal Direction
Yield Strength [MPa]	664	275	na
Tensile Strength [MPa]	915	485	na
Elongation (%)	72	30	na
Impact toughness [J]	197	-	181

POWDER BED FUSION - ELECTRON BEAM (AS BUILT)

0 0

Parameter	Vertical Direction	ASTM F3056 14a	Horizontal Direction
Yield Strength [MPa]	350	275	350
Tensile Strength [MPa]	670	485	670
Elongation (%)	60	30	40
Impact toughness [J]	100	-	95

ALLOY DESIGN AND OPTIMISATION RELATIVE DENSITY VS ENERGY DENSITY



ALLOY OPTIMISATION HIGH TEMPERATURE NICKEL SUPERALLOY





ALLOY OPTIMISATION HIGH TEMPERATURE NICKEL SUPERALLOY



OPTIMISED COMPOSITIONS



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NICKEL SUPER ALLOY OPTIMISATION

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