Electron Beam Cold Hearth Remelting of Titanium and Scrap Control by LIBS Technology

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Electron Beam Cold Hearth Remelting Furnace (EBCHR) - Facility

Mixing unit - weighing hopper

Drum feeder

6 Guns - melting chamber

Scrap, sponge, alloying elements

EB furnace

Slab or ingot
Electron Beam Cold Hearth Remelting Furnace (EBCHR) - Scrap revert strategy

Since 2008, the VDM performs a successful scrap revert strategy.

Feeding material:
- Titanium sponge
- Scrap as feedstock, chips (loose or compacted), cobbles, etc.
- Every ratio of each, sponge and scrap
- Automatic weighing and mixing systems for sponge, scrap, master alloys, micro components

The scrap ratio is typically 75%.
Electron Beam Cold Hearth Remelting Furnace (EBCHR) - Melting

**Process control:**
- Automatic Beam Power Distribution Control (ESCOSYS)
- Process observation by 6 viewing systems

**Melting rate:**
- up to 1,600 kg/h
Electron Beam Cold Hearth Remelting Furnace (EBCHR)
- Skull of melting and refining
Electron Beam Cold Hearth Remelting Furnace (EBCHR) - Grades and Sizes

**Grades:**
- Grade 1s (low oxygen content)
- Grade 1 and 2
- Ti-0.8Ni-0.3Mo (grade 12)
- Ti-6Al-4V (grade 5)
- Ti-6Al-4V ELI (grade 23)
- Ti-3Al-2.5V (grade 9)

**Product sizes:**
- Ingots: 845 mm dia x 5.5 m (13.5 t)
- Slabs: 500 x 1,300 mm x 5.5 m (16 t)
- Slabs: 500 x 1,050 mm x 5.5 m (13 t)
- Slabs: 375 x 1,355 mm x 5.5 m (12.5 t)
- Slabs: 375 x 1,100 mm x 5.5 m (10.2 t)
Electron Beam Cold Hearth Remelting Furnace (EBCHR) - Analysis Ti-6Al-4V slab

Chemical composition along the slab length 611340E:
- Aluminum
- Vanadium
- Iron
- Oxygen, Carbon, Nitrogen

611340E, 1050x500mm, 6.2t, Gr.5, Melt Sampling EB

Ti-6Al-4V
1050 x 500 x 2700 mm
Weight: 6.2 t
Electron Beam Cold Hearth Remelting Furnace (EBCHR)
- Analysis Ti-6Al-4V ingot - EB + VAR

Chemical composition along the ingot length 612183E:
- Aluminum
- Vanadium
- Iron
- Oxygen, Carbon, Nitrogen

612183E, Ø845mm, Gr.5, 12t, Melt Sampling EB, drill VAR

Ti-6Al-4V
Ø845mm x 4700mm
Weight: 12 t
RETURN – Process Chain: Recycling of Titanium Chips

RETURN consortium:
- CeramTec - Cutting materials
- Cronimet - Recycling
- Deharde - Machining
- Institute of Production Engineering and Machine Tools, Uni Hannover - Machining
- Institute for Material Science, Uni Hannover - Material analysis
- MAG IAS - Manufacturer of milling machines
- Premium Aerotec - Machining
- VDM Metals - Melting
- Walter - Cutting tools

Aim: improvement of the “chip quality” without decreasing of the
- component quality
- component manufacturing
RETURN – Process Chain: Recycling of Titanium Chips

The role of VDM Metals: building up an innovative scrap/chip control

Initial goal:
- to capture every chip
- to inspect every chip
- to analyze every chip

Requirements:
- fast system
- automatic system

Possible solution:
- LIBS system (laser-induced breakdown spectroscopy)

Questions - to capture every chip:
- is it possible?
- is it necessary?

All results should be transferable to solids (feed stock).

In this project the fundamentals and requirements should be developed.
RETURN – Process Chain: Recycling of Titanium Chips

Feeding hopper

Vibration Channel for chip separation

Checking or analyzing by LIBS

Settling section
RETURN – Process Chain: Recycling of Titanium Chips

Score plot of the principal component analysis: PC0 and PC1
RETURN – Process Chain: Recycling of Titanium Chips

Score plot of the principal component analysis: PC0 and PC1
RETURN – Process Chain: Recycling of Titanium Chips

Score plot of the principal component analysis: PC0 and PC1

In order to clearly distinguish the various Ti-alloys, more work is planned.
RETURN – Process Chain: Recycling of Titanium Chips

- Inspection line provided by PROASSORT
- LIBS unit provided by SECOPTA

An experimental example is shown in a movie: (click picture on the left)

- Belt speed: 1 m/sec
- Laser: max. 20,000 shots/sec
- 7 shots summarized for an analysis
- 8 msec for an analysis
Projekt Return
Titan Späne
Thank you for your attention