First time right - Industrialize DED

Formnext Connect 2020
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First time right - Industrialize DED

„Let’s always realize a constant distance!“

1. Introduction DED (LMD) technology and PARADDISE
2. PRECITEC OCT System
3. Layer Thickness Control
4. System implementation in IBARMIA DED Hybrid machine

DED process out of focus
System integration
DED – Directed Energy Deposition
Basic Principle and Advantages

Principle of Directed Energy Deposition

Advantages:
- High building rates
- Deposition on existing parts
- Low heat input → Small HAZ (heat affected zone)
- Low dilution rate
- Homogeneous microstructure with excellent adhesion properties
- Flexibility in dimensions
- Multi material parts and material transition

Main Applications of Directed Energy Deposition

Prototyping and Manufacturing
Repair and Welding
Coating
DI seamless digital Additive Manufacturing chain for DED

**Product manufacturer perspective**

1. **Product design**
   - NX CAD
   - Component simulation
   - Topology Optimization

2. **Production planning**
   - Process simulation
   - SimCenter

3. **Production engineering**
   - Manufacturing preparation NX CAM

4. **Production execution**
   - Operation and execution (MOM/MES)
   - Security and quality

5. **Service**
   - Machine control and automation
   - Machine data analytics
   - MindSphere

**GKN turbine housing**

- Definition of Layer Thickness
- Closed loop process control ensures constant Layer thickness
- Technology Tests, Experience, Parameter from providers

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Collaboration with strong partners in the EU Project PARADDISE
A **Productive**, **Affordable** and **Reliable** solution for large scale manufacturing of metallic components by combining laser-based **ADDitive** and **Subtractive** processes with high **Efficiency**

### PARADDISE participants

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### PARADDISE work packages

- **WP2. Combined AM & SM Process**
  - AM & SM processes
  - Technology indicators
  - Process models
  - Materials

- **WP3. CAM for AM&SM**
  - CAM
  - CAD
  - CAE

- **WP4. Smart components, control and monitoring**
  - Smart Powder feeder
  - Smart LMD Head
  - Closed control loops
  - Monitoring system
  - SIEMENS

### PARADDISE

- **START DATE:** 01 October 2016
- **DURATION:** 36 months (prolongation 6 months)
- **Project Extension:** 6 months
- **Call topic:** FOF-13-2016 - Photonics Laser Based Production
- **Budget:** 3,761,403€
DED process is influenced by many factors

- Nozzle distance, layer thickness
- Melt pool dimension → Laser Power (Width control)
- Temperature distribution in LMD head
- Temperature distribution in part

DED process with parameters and controlled variables with focus on:

- Layer Thickness control / monitoring
- Laser Power/ width Control
Closed Loop Motion Control for DED

- In process measurement of nozzle distance
- Integrable in various LMD Heads

Algorithm for Feed Rate Control
- Process model
- SINUMERIK 840D/ONE (Compile cycle)

Layer Thickness Monitoring/Control

- Uncontrolled, controlled process
- Test in IBARMIA ZVH45
OCT System from PRECITEC enables an precise distance measurement

Precitec OCT system measures the distance between Nozzle and melt pool during the DED process.

The Sensor is using the existing optical system of DED Head.

- Principle of IDM-Sensor based on low-coherence interferometry (LCI)
- OCT optical coherence tomography

Low-coherence interferometry (LCI)
- Incoming light is split into a reference and a measuring path
- Optical path difference (OPD) between both paths is analyzed
- The distance information can be extracted by applying a FFT
- Process light and particle stream do not disturb the measurement
First successful System tests on typical DED parts

Hashtag: Crossing walls

Standard DED process with imperfections

Controlled DED process

Siemens Motor cover part

Closed-loop motion control

Results

- IDM Sensor delivers reliable distance values during the DED Process
- Feed rate has the main impact on the layer thickness and is easy to control
- Control algorithms has to be adapted on various building strategy
Comparison non controlled and controlled DED process

Closed-loop motion control

Process monitoring with Precitec IDM OCT sensor and Siemens closed-loop motion control as part of EU funded PARADDISE project
“Geo Mapping” on base of Sinumerik Integrate Tools

Interactive definition of rules for impacting parameters

- Parameter limits, e.g. layer height during LMD process
- Definition of display style
System implementation in industrial DED hybrid machine
IBARMIA ZVH45 Hybrid

Closed loop motion control system was successfully integrated into the IBARMIA DED hybrid machine ZVH45 and tested at the Tecnalia Institute in San Sebastian.
IBARMIA Hybrid Machine ZVH45

Closed Loop Motion Control system is running well at IBARMIA DED hybrid machine ZVH45
Test in industrial DED machine IBARMIA ZVH45 Hybrid

Closed Loop Motion Control system is running well at IBARMIA DED hybrid machine ZVH45
„Let‘s always realize a constant distance!“

1. Inline distance measurement with OCT systems is running well ✓
2. Successful results in measuring as well as closed loop control ✓ ✓
3. Test in industrial environment ✓

Please keep informed about the Siemens / Precitec product development!
Always at defined constant distance!

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