Sensors for stable high precision laser cladding processes

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Laser Cladding Characteristics

- Metallurgical bonding between substrate and cladding
- High precision of heat transfer
  - Minimum dilution with base material possible
  - Minimum dimensions of heat affected zones, thermal treatment and distortion of base material possible
- Precise material deposition
- High process stability and reproducibility
  - High homogeneity of microstructure
  - Pre-condition for automation given
- Low porosity achievable
- But: Tolerances (temperature, working distance) take strong influence!
Laser Power Control

- Evaluation of emission from melt pool
- Compensation of increasing or decreasing component temperature
- Prevention of optics thermal overload

CCD camera (mounted)

Evaluation unit
LPowC

- User defined (circular) emission evaluation areas for I: laser power control and II: optics protection
- Definition of emission value limits based on recordings of optimal process
- LPowC produces digital signals that indicate violation of limits
- Laser cladding installation PLC uses digital signals to realize closed loop control of laser power
LPowC cladding tests

- 316L steel, 28 x 1.2 mm
- 3 types of powders:
  - FeCrV15, +63 - 180 μm
  - NiBSi 22HRC, +20 - 53 μm
  - Stellite® 6, +63 - 150 μm
- Cladding thickness: 0.65 - 1.0 mm
LPowC cladding tests

FeCrV15  NiBSi 22HRC  Stellite®6
LPowC FeCrV15
LPowC NiBSi 22 HRC
LPowC Hardness

![Graph showing microhardness (HV0.3) vs cladding distance (mm)]
- Detection of laser beam focus center by powder nozzle bore center
- Definition of area of interest (yellow) and grey scale value & gradient criteria for automatic edge detection (blue)
- Error correction function by maximum permissible deviation of edge position and inclination compared to previous measurement
- Setting of optimal reversal points based on pre-investigations
- High precision of cladding process permits near net shape cladding and minimizes hard machining time & costs
- Screw flight geometry alteration along screw axes and conicity result in extensive handling programming demands
- Susceptibility to cracking of typical cladding material usually requires pre-heating and temperature control during cladding process
Temperature deviations during cladding process result in undefined position of screw flights.

Concentricity tolerances of small diameter screws require compensation in cladding head movement to keep working distance in acceptable range.
LPosC

Extruder screw cladding center, including:

- LPosC edge detection for automatic compensation of thermally induced screw elongation or shrinkage
- Concentricity tolerance compensation in vertical and horizontal direction based on online screw surface monitoring (2D laser distance meters)
LPosC

- Triggered component illumination for edge detection
Summary

- LPowC permits production of claddings with homogeneous microstructure, shape and microhardness despite extreme change of component temperature during cladding.
- If inadequate parameters are chosen, LPowC will keep inadequate process constant.
- LPosC is capable of detecting groove edges and adjust laser cladding head positioning due to thermally induced component elongation / shrinkage.
- Learn more about laser cladding process control @ GTV booth!
Thank you very much for your attention!