GTV Presentation
- Laser Cladding -
GTV Cooperation Partners

- Laserline, Mühlheim
  High Power Diode Lasers
- IPG, Burbach
  Fibre Lasers
GTV Cooperation Partners

- HighYag, Stahnsdorf
  Laser Optics and Fibres
GTV Cooperation Partners

- Fraunhofer IWS, Dresden
  Powder nozzles, CAM Software, Research

NiCrBSi - 60% FTC
GTV Laser Cladding Center

- 4 x 3 x 3 m Laser Booth
- 6 kW Diode Laser
- Laserline Optics with camera for process control
- KUKA KR30HA - 8 axes
- Powder Feeder TWIN 3/3
- Lathe WSB 1
- Turntable DT300
Powder Feeders
GTV Stand alone TWIN MF 2/2

- Compact design
- Completely PLC controlled (Siemens S7)
- 2 Powder feeder hoppers, volume: 0.3 l, 1.5 l, 5.5 l
- Mass flow controlled carrier gas lines, 2 different gases can be chosen
- Mixer for homogeneous feed of powder into disk grooves
- Different disk grooves for optimal process stability at powder feed rates between 0.5 g/min - 150 g/min
- Process visualisation on color touchscreen monitor Siemens TP177B
- Fine gas filters for protection of components
- Heating jackets available on demand
- Different remote control interfaces available (PLC inputs, Profi-Bus)
GTV TWIN MF 2/2-PG

- Compact design
- Completely PLC controlled (Siemens S7)
- 2 Powder feeder hoppers (here just one installed), volume: 0.3 l, 1.5 l, 5.5 l
- Mass flow controlled carrier and process gas lines, 2 different gases can be chosen
- Mixer for homogeneous feed of powder into disk grooves
- Different disk grooves for optimal process stability at powder feed rates between 0.5 g/min - 150 g/min
- Process visualisation on color touchscreen monitor Siemens TP177B
- Fine gas filters for protection of components
- Heating jackets available on demand
- Different remote control interfaces available (PLC inputs, Profi-Bus)
- Additional monitoring of cooling water possible
GTV TWIN MF 2/2-PG + Operator Panel

- Compact TWIN MF 2/2-PG Controller without TP177B operator panel
- Remote control of all installation components by TWIN MF 2/2-PG PLC (handling incl. robot hand-shake, chiller, filter, laser source, etc.)
- Large Operator Panel including process camera display on second monitor for complete process visualisation
- Complete Safety-chain with emergency switch
- Door safety switch can be integrated
- Special customer demands can be realized
Powder Nozzles
Laser Cladding

- Lateral powder feed nozzles can easily be added to different kinds of laser optics, but show the disadvantage of deposit geometry depending on cladding direction and reduced deposition efficiency compared to coaxial feed.
Laser Cladding

- For coaxial powder feed different powder nozzles are available for various manufacturer´s laser optics tailored for different applications.
Laser Cladding

- Annular gap powder nozzles are used most frequently in laser cladding processes and typically permit +/- 30 ° tilting angle without detrimental effect

- Typically powder focus 1-2.5 mm and welding seam width < 10 mm are applied; deposition efficiency can be up to 95% and depending on laser power up to 9 kg/h deposition rate is possible
Laser Cladding

- Annular gap nozzles for 1-inch optics are restricted to laser power levels of less than 4 kW, but small dimensions permit easier access to various surface areas on complex shaped components.
- Typically powder focus 1-2.5 mm and welding seam width < 5 mm are applied; typically up to 4 kg/h deposition rate can be achieved.
Laser Cladding

- Special powder nozzles for rectangular-symmetrical alignment of powder feed and rectangular focal spot of high power diode lasers permit seam width 8 - 22 mm and bead geometry comparable to PTA.
- Deposition efficiency can be up to 90% and depending on laser power up to 6 kg/h deposition rate is possible; only metallic powders can be applied sensibly in order to maintain long nozzle life time.
Laser Cladding

- Replacement of annular gap powder nozzles by typically 3 or 4 grooves in the inner cone of the powder nozzle to permit any desired tilting angle of laser heads without detrimental effect by gravity.

- Typically powder focus 2-3 mm and welding seam width < 8 mm are applied; deposition efficiency can be up to 95% and depending on laser power up to 5 kg/h deposition rate is possible.
Laser Cladding

- For improved access to functional areas to be coated special powder nozzles with long narrow (typically 30 mm) body are available; grooved powder nozzle cones permit 3D repair and build-up jobs.
- Typically immersion depths up to 200 mm and maximum spot width 4 mm are applied.
- High beam quality lasers (Nd:YAG or disk lasers) with < 3 kW power.
Laser Cladding

- For cladding of internal surfaces special integrated laser heads permit coating of internal diameters > 60 mm with < 1,000 mm length
- Typically weld seam width < 4 mm is applied for internal coating of automotive engines, turbine or landing gear components
- High beam quality lasers (Nd:YAG or disk lasers) with < 3.5 kW power
Laser Cladding

- Depending on the depth of internal surfaces conventional powder nozzles can be applied.
- For deep coating of internal surfaces adapted laser heads with tailored powder feed and cooling setups have been developed.
Applications
Laser Cladding

- Deposition of protective coatings

Wear protection of stone crushers (NiBSi/FTC)

Hardfacing of steam turbine edge to fight erosion by wet steam (Stellite 21)
Laser Cladding

- Deposition of protective coatings

Wear protection of oil drilling tools
(NiBSi/FTC)
Laser Cladding

- Deposition of protective coatings

Wear protection of oil drilling tools
(NiBSi/FTC)
Laser Cladding

- Deposition of protective coatings

Wear protection of industrial meat knifes
(Iron based hard alloys)
Laser Cladding

- Deposition of protective coatings

Wear and liquid metal corrosion protection of steel mill sink pot rolls (CGL) (Tribaloy 400, Tribaloy 700)

Wear protection of cast aluminum combustion engines ($\text{Al}_2\text{O}_3/\text{TiO}_2$)
Laser Cladding

- Deposition of protective coatings

Wear protection of concrete mixers
(NiBSi/FTC)

Wear protection of paper pulp blades
(NiBSi/FTC)
Laser Cladding

- Deposition of protective coatings

Wear protection of bearings  
(Stellite)  

Wear protection of valve body  
(Stellite)
Laser Cladding

- Wire feedstock is typically added laterally in laser cladding processes, but problems concerning precise positioning of the wire tip result in limitations concerning complex shape build-ups.
- Special laser heads with e.g. triple beam focus on an axially fed wire tip permit to overcome such shortcomings.
- Typically wire diameter 0.8 - 1.2 mm
- Typically < 6 kW laser power
- Variable focus diameter
- Special wire feed for cored wires that permit wide material spectrum
Repair of Ti6242 blisks of aero engines permits higher strength of blades than wrought material due to epitactic crystal growth in combined cladding / milling machines.
Laser Cladding

- Repair of Ti6242 blisks of aero engines permits higher strength of blades than wrought material due to epitactic crystal growth in combined cladding / milling machines.
Laser Cladding

- Repair of expensive components like crankshafts or aero engine housings as well as parts that are not easily available like old cars piston ring seats
Laser Cladding

- Rapid Prototyping / Rapid Tooling of moulds

Stellite 21
Laser Cladding

- Rapid Prototyping / Rapid Tooling of moulds in combined cladding / milling machines
Hybrid Laser Cladding Processes

- Inductive heating support of the laser cladding process permits increased deposition rate; e.g. 8 kg/h deposition rate of Inconel 625 for 4 kW laser and 14 kW induction power source
- Inductive heating permits easier welding of and on crack-prone materials
- Typically < 6 mm laser spot diameter, < 8 kW laser power
- Focus length \( f \) > 177 mm
- Total head weight < 15 kg
Laser Cladding

- Rapid Prototyping / Rapid Tooling of moulds using hybrid inductively supported laser cladding process
Hybrid Laser Cladding Processes

- Heating of powder feedstock by efficient, low-cost oxy-acetylene flame with injection into the melt pool created by the laser in order to improve the cladding process efficiency significantly
- Lateral powder feed can be adapted easily; integrated laser heads with axial feed of pre-heated powder and electrical resistance pre-heating of axially fed wires under development
Common Laser / TS Applications

- Especially in aero engine and industrial gas turbine industries there are various components that require thermal spray coatings, laser claddings or other laser based process treatments.
- Combined thermal spray / laser process installations give access to optimized efficiency concerning machine use; additionally some parts require both processes on one part.
Common Laser / TS Applications

Turbine blade surface engineering tasks:

- Functional coatings on turbine blade tips (clearance control and titanium fire prevention)
- Turbine root coatings to prevent cold welding of titanium parts
- Erosion protection of midspans
- Droplet impact erosion of wet steam turbine blade edges
- Hot gas corrosion protective coatings
- Thermal insulation coatings
- Fatigue life time improvement by laser peening
Common Laser / TS Applications

- Zinc pot and stabilizing rolls are typically coated on their mantle with hardmetal using HVOF, while shaft bearing seats are protected by laser cladding with special iron based alloys.
Thank you very much for your attention!