Laser Roll Cladding

Laser-based Joining in the Gap for Continuous Production of High-Strength Mixed Metal Joints

Joining in a roll gap offers several advantages in the production of metallic semi-finished products and structures. A continuous process with high production rates increases the cost-effectiveness and energy efficiency of production.

Energy transition goals, especially with regard to saving carbon dioxide emissions, pose complex challenges for the industry. Innovative manufacturing concepts and weight reduction are two approaches currently being pursued in the mobility and construction industries. For instance, lightweight design concepts envision the increased use of aluminum materials to significantly reduce vehicle weight. In vehicle electrical and body components, however, conventional materials such as copper or steel can hardly be replaced due to their specific properties. Mixed construction methods are required here involving numerous joining challenges. Conventional fusion welding processes simply cannot be used to produce mixed joints of aluminum with steels or copper materials that are suitable for the stresses to which they are subjected. This demands alternative joining concepts and suitable semi-finished products. In collaboration with several industry partners, Fraunhofer IWS has developed a special cladding process that facilitates joining hard-to-join metals with extremly high strength. Joining in a roll gap offers several advantages in the production of metallic semi-finished products and structures. A continuous process with high production rates increases the profitability and energy efficiency of production.

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Roll Cladding Process Joins Metals that are Difficult to Join

Laser roll cladding makes it possible to produce bimetallic semi-finished products for further use in different components. Unlike conventional cladding processes, in laser roll cladding the two starting semi-finished products are fed as strip material at an angle to the roll gap. A laser beam formed into a line heats the inner strip surfaces to process temperature immediately before the roll gap. This produces material composites with high strengths and good cold formability. The process is also suitable for combining steel or copper with aluminum alloys.

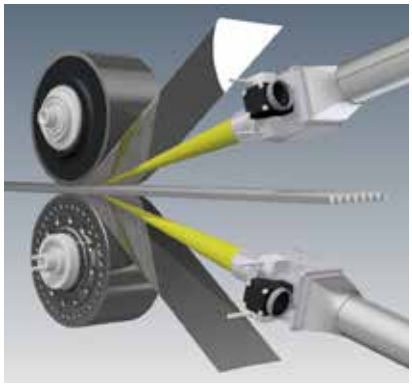
The joining principle can also be used to continuously produce all-metal lightweight structures. In this process, the laser joins a core element in the roll gap to the surface layers. By using several lasers and modern beam shaping systems, the process can be flexibly adapted to different geometries. The creation of the core element by an upstream roll forming process can further increase the cost-effectiveness of laser roll cladding. The process uses all metal alloys available in sheet form and thus enables production from the roll. One advantage over conventional extrusion is the ability to produce rigid structures with very thin walls, thus saving material and weight.

Application Examples

A wide variety of materials can be combined using the Fraunhofer IWS laser roll cladding process. Joints achievable include bimetallic joints of nearly all types of steel, steel and copper, steel and aluminum, copper and aluminum, and silver-based contact materials with silver or copper alloys. These can be used to manufacture a variety of components, such as

- battery cell connectors in mixed plated strip design, which allow aluminum or copper electrodes to be joined with a permanently low electrical contact resistance,
- laser roll-clad aluminum-steel connecting elements (transition joints) for welded and deepdrawn hybrid circuit boards in vehicle construction,
- bearing materials in combination with steel for the manufacture of plain bearings, and
- switching contacts for various industrial applications.

A current research project aims to develop a scalable, cost-effective and large-scale production process for the manufacture of fuel cells. One focus is laser roll welding of bipolar plates (BPP) for continuous and effective joining of preformed bipolar half-shells from the roll at strip speeds of up to 30 m/min or 1 BPP/s. In comparison to remote welding, this process avoids the need for complex clamping concepts.



Process principle: Metal strips, sheets or structural elements are fed between two rollers at an angle to each other. The laser beam heats the contact surfaces in the roll gap to process temperature. Pressing the joining partners together produces high-strength joints.

Laser Roll Cladding System

For the process development at Fraunhofer IWS a roll cladding line with the following equipment features is used:

Technical Data

- Roll stand with turret head arrangement
- Inductive preheating of the strip materials
- Strip widths up to 140 mm
- Width of the joining zone:
  - Line: max. 22 mm
  - Scanner: 140 mm
- Strip guiding with decoilers, straighteners and dancer control
- 8 kW disk laser
- 4 kW fiber laser
- Optional: inert gas enclosure

Further information

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