ALOtec Dresden

Laser Hardening of tools and machine components

1. General

Hardening of tools and machine components is used to increase strength and wear resistance. A distinction is made between processes hardening the whole component, such as common furnace hardening and plasma nitriding, and partial acting processes such as flame hardening, induction hardening and laser hardening.

Partial hardening of functional surfaces, which are subject to wear, is increasingly favored. Basic strength in the tool core remains while susceptibility to cracking is clearly reduced.

The advantage of laser hardening compared to flame or induction hardening is the lower amount of energy input into the component. Structures are fine-grained, distortion is much lower to non-significant and in therefore there is less or no rework.

For about 10 years laser hardening as a surface hardening process is suitable for industrial applications and under ongoing development at the same time. In addition to the CO_2 laser and Nd:YAG laser, direct radiating and fiber-coupled high power diode laser (HPDL) are available. The advantage of the HPDL is its shorter wavelength. Thus a clearly better absorption of energy behavior of the material with efficiency at about 35 % is achieved.

For laser hardening of directly curable materials a minimum carbon content of 0.2 % is required but also carburized or nitratable steels can be hardened with this technology.

The surface hardening process is suitable for construction steel, quenched and tempered steel, tool steel and cast steel as well as miscellaneous sorts of cast iron like lamellar graphite or nodular graphite cast iron.

Laser beam technology allows the partial hardening of edges, arbitrary contours as well as specific points. 2D or 3D contours, knobs or scar structures, can be hardened. The only requirement is the free access of the focused laser beam on the component surface which shall be hardened.

The component surface is controlled heated by the laser beam with a temperature rise of more than 1000 K per second to temperature of austenitizing. Time at temperature is maintained for an interval between 10^{-3} s to 10 s as accurately as possible below the melting point.

The maximum achievable surface hardness depth is about 0.8 mm to 1.5 mm depending on the deployed material. It is determined by the time to heat the material to temperature of austenitizing and the material-specific cooling rate to the component core. Using high-alloyed air hardening steels even greater hardening depths can be achieved. The degree of hardness is in the upper limit achievable by martensite hardening. Track widths up to 60 mm are possible.

If laser hardening is done under atmospheric conditions an easily removable oxide layer arises. This scaling is prevented using protective gas.

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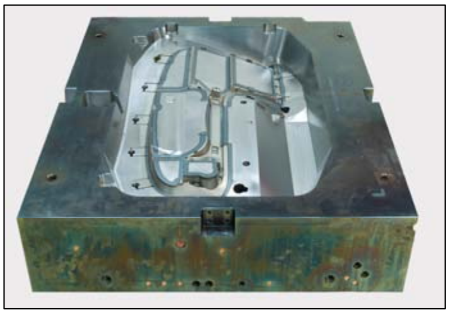

Figure 1 Partial hardening along the closing edge of a molding tool

To increase the hardening depth at selected points and contours a combination of laminar plasma nitriding and partial laser hardening is possible.

The advantage of laser hardening are high energy efficiency and high processing speed and so fast availability of the hardened component for the following manufacturing or production process. There are no external processes or additional media, such as artificial vacuum, water or oil needed.

2. Industrial Solutions Provided By ALOtec Dresden

ALOtec offers entire customer-specific laser hardening systems. The system contains of a diode laser with its optics attached to a 6-axis robot and an additional tilt-table for component positioning. This combination provides the accessibility of the laser beam to the component surface with no exception.

The deployed laser power control LompocPro ensures the best temperature stability on the component surface, even at varying heat dissipation conditions. The surface temperature is precisely measured with a camera and allocated by the laser power control to the temperature values of the surface element within the hardening track. To create a uniform hardness result a precision of the temperature field of approximately +/- 10 K is provided. Melting is definitively prevented.

Other process parameters, such as feed rate of the laser beam and beam angles due to geometrical characteristics of material, are set and evaluated through the experience of many hardening processes. Scanning systems enable the system to reach areas in the inside of a component with an optimal laser impact angle to the surface.

ALOtec designs laser hardening systems to meet special customer requirements. These systems are expandable for laser powder cladding and laser wire build-up welding. In addition, we offer laser hardening as a service in Dresden and since the beginning of this year mobile hardening directly at our customer's site.

Systems of ALOtec are in use worldwide.

News

The dynamic scanning system LaSSy, developed at the Fraunhofer IWS Dresden, allows variable laser beam intensity profiles and hardening track widths at a frequency up to 200 Hz. The laser beam can variably follow surface contours or omit them. Swapping of installed optics for change of track widths is omitted. Slip zones are avoided.

Using the especially for laser applications developed software DCAM the route of the laser beam is efficiently programmed offline. CAD data can be imported from all common CAD systems or created by teach-in.

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The module LasMon analyzes laser sources and laser optics, measures the power density distribution of shaped laser beams and displays them.

With the small laser system "Plug and Work", we provide our customers with a production-ready system at a price well below the common level.

Figure 2 mobile laser hardening system at ALOtec Dresden

3. Summary

In the tool production advantageous technical solutions for manufacturing and machining process are favored, which can be implemented applied fast and cost effective. Laser hardening allows an already cut tool to harden selective and partially, without any rework. Immediately after hardening the tool is ready for production.

literature: Bonß,S.:HTM Z. Werkst.Wärmebeh.Fertigung 63(2008)

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