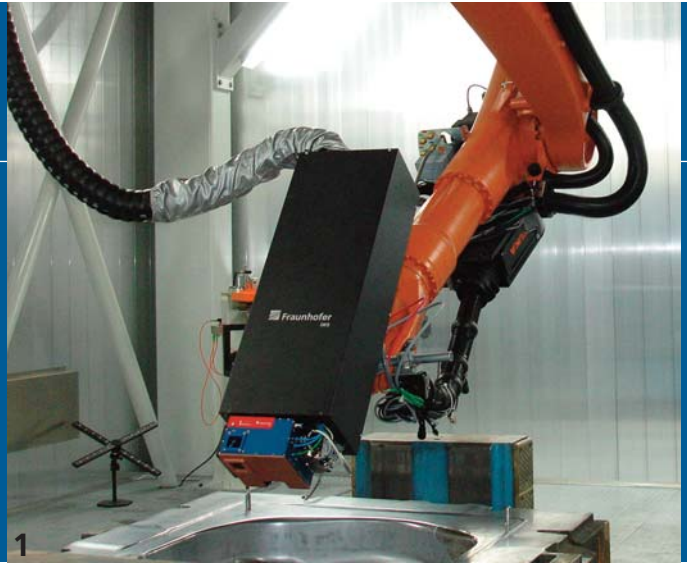

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LASER BEAM HARDENING FOR CAR BODY TOOLMAKERS

THE TASK

Making a car body requires approximately 350 sheet metal parts. Each one of these parts requires toolsets of up to five stages. The use of higher strength sheet metals in car bodies increases tool wear during cutting and forming operations. Cutting tools are made from highly alloyed tool steels. The cutting edges suffer higher loads. Forming is accomplished with grey cast iron tools facing increased contact pressures. Thus tool wear becomes critical.

Simultaneously tools are getting more costly as a consequence of shortened product lifecycles and increasing product varieties. However, tool costs and also manufacturing times need to be reduced. The approach is to increase the wear resistance on those tool surfaces that suffer the highest loads. It is also important to implement this surface treatment at the toolmaker's shop. This reduces costs for transporting the tools to service providers and saves time.

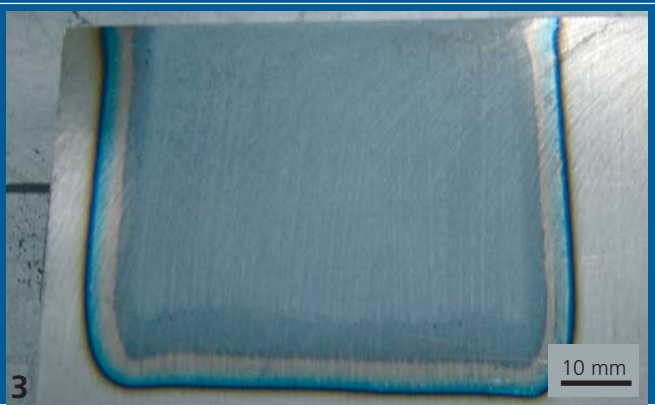
OUR SOLUTION

Laser beam hardening has become a competitive technology to processes such as flame and induction hardening, which were typically used to treat large tools. The laser process has the advantage that it is very precise and reproducible. It is using advanced process monitoring and control components. Laser beam hardening occurs at atmospheric pressures without addition gases or liquids.

Its integration with machining operations in tool making is uncomplicated. A 2002 - 2006 BMBF project advanced this technology at a level that today's toolmakers want their own laser hardening plant, whether they belong to an automotive manufacturer or are independent toolmakers. The preferred system concept is to use buckling arm robots on or at a linear axis. This concept is suitable for large workspaces, which is mostly defined by the size of the car side frame tool. A robot-controlled process is ideal for moving tools of non-rotational symmetry on six axes. Such a tool is for example and often-used rectangular laser beam.

Fraunhofer IWS engineers developed the dynamic laser beam shaping unit "LASSY". Vibrational mirrors are used to generate quasi-static beam profiles with variable intensity distributions. Such flexible intensity distributions are required to create uniform hardening depths even if the local thermal energy dissipation conditions vary along the treatment zone. The process also makes use of the camera based temperature measurement system "E-MAqS". This system measures the surface temperature distribution on the part inside the laser beam.

The controller "LompocPro" regulates the laser power so that the surface temperature during process remains constant within a few kelvins. Process data including the temperature distribution information obtained via "E-MAqS" are recorded. These data can be provided to other systems for quality control purposes.



The process speed is relatively low when treating large tools. Here the operator can fine-tune the beam shaping for the tool even while it is being treated. To do this the dynamic beam shaping system is adjusted to match the false color image of the temperature measurements. A proven approach when using a robot is to dock a laser module via an exchange coupling. The module contains the laser optics, the beam shaping unit with integrated temperature measurement and the electronic control components. The laser fiber and all cables and lines are also held. A cover protects the components from dirt. The laser module is mounted to the robot hand with a joint that can be fixed in two positions. The laser beam can then exit at 90° or 45° with respect to the sixth robot axis. This increases the access possibilities to the part. The exchange coupling is used so that one can use selectively other laser modules for example for measurements or buildup welding processes. Toolmakers of large tools are in particular interested in the combination of hardening and buildup welding processes.

RESULTS

In 2010 a hardening and buildup welding plant with laser module and IWS process components was delivered to Audi AG in Ingolstadt. The robot is attached to a ceiling mounted linear axis. The plant is designed and positioned so that standard palettes holding the tools move automatically from machining to laser processing operations.

The laser source is a fiber coupled 6 kW diode laser. This laser creates hardened surface tracks of up to 60 mm width. A second fiber port is used by the buildup welding module. Fraunhofer IWS engineers supported Audi AG during startup and delivered the technology know how.

In 2012 a similar system was delivered to Volkswagen AG in Wolfsburg. This plant can handle tools with a footprint of up to 2.5 x 6 m^2 and a weight of 25 tons. Here too IWS engineering provided all the necessary process components and the operator training. The latter was done directly with the installed machine. The in-house hardening capability saves Volkswagen AG valuable time in making tools.

1 Laser hardening module at the robot, system at Audi AG Ingolstadt
2 Hardening process for large tools at Audi AG Ingolstadt
3 Test hardening of the material 1.2379, 60 mm wide, about 1.5 mm deep

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