Laser polishes components to a high-gloss finish

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At present, components used in areas such as tool and die making generally have to be painstakingly polished by hand – but a recently developed automated process could soon offer a much faster solution. From November 29 to December 2 at the 2011 EuroMold exhibition in Frankfurt, Fraunhofer researchers will be presenting a machine tool that uses laser polishing to give even complex 3D surfaces a high-gloss finish.

Millimeter by millimeter, the polisher uses grinding stones and polishing pastes to polish the surface of a metal mold, working at a rate of some ten minutes per square centimeter. This activity is time-consuming and hence incurs a significant cost. What is more, many companies are struggling to find new recruits for such a challenging yet monotonous task.

But the era of laborious hand polishing could soon be over: In collaboration with the companies Maschinenfabrik Arnold and S&F Systemtechnik, researchers at the Fraunhofer Institute for Laser Technology ILT have developed a novel type of machine tool which can polish both simple and complex surfaces using laser beams. "Conventional methods remove material from the surface to even it out. Our method is different: It uses a laser to melt a thin surface layer roughly 20 to 100 µm deep," says Dr.-Ing. Edgar Willenborg, Section Head at the ILT in Aachen. "Surface tension – a property that applies to all liquids – ensures that the layer of liquid metal solidifies evenly."

Depending on the material, the project team can already produce surfaces with an average roughness (Ra) of between 0.1 and 0.4 µm. "Hand polishing can still get better results than that," Willenborg admits, "but the point is that in many applications – for example molds for glass-making, forming and forging tools – a medium-quality surface is all that is needed". The new machine developed at the Aachen-based ILT has the potential to save considerable amounts of time and money in these areas:

The machine polishes surfaces up to ten times faster than a hand polisher and is an excellent option for serial production and for polishing small batches.

The new laser polishing system consists of a 5-axis gantry system plus an additional 3-axis laser scanner, a design that enables the workpiece to be accessed from all sides. Carefully arranged mirrors deflect the laser beam to allow feed rates (the speed at which the laser beam moves along the workpiece within a specified time frame) in excess of one meter a second, even on small surfaces. An end-to-end CAM NC data chain has also been developed which draws on a 3D CAD model of the component to be polished. The beam path data is calculated on the basis of this model. "For this step, we use conventional computer-aided manufacturing (CAM) programs such as those used in milling processes. The advantage is that companies are typically already running those kinds of programs so the employees know how to use them," says Willenborg. The calculated beam path data is then supplied to a special post-processing software program developed at the ILT. This program configures more advanced aspects – for example adapting the laser to the specific angle of incidence and component edges in each particular case.

This new process technology also offers benefits in terms of machine development: "The fact that we are working with a completely new

operating principle makes it much easier to construct the machines we need," Willenborg says. "Unlike conventional polishing techniques, laser polishing does not primarily rely on the rigidity of the machine to achieve high component quality, but rather on the physics of surface tension."

The laser polishing machine will soon be ready for market launch. This year‘s EuroMold fair is the first time the researchers have presented their new development to the public.

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