poliMATIC

AUTOMATED POLISHING FOR THE EUROPEAN TOOLING INDUSTRY

SEVENTH FRAMEWORK PROGRAMME

poliMATIC – **Strengthening the competitiveness of the European Tooling Industry by automating the polishing process**

Concept and Objectives

For the manufacturing of tools 12 to 15 % of the manufacturing costs and 30 to 50 % of the manufacturing time are allocated to polishing. As current automated polishing techniques are almost not applicable on parts with freeform surfaces and function relevant edges like 95 % of the tools, the polishing is predominantly done manually. Therefore the overall objective of poliMATIC is to strengthen the competitiveness of the European Tooling Industry by overcoming the current drawbacks of die and mould finishing by realising automation in laser polishing and force controlled robot polishing.

To ensure relevance to targeted markets and practical use of the results, the project is strongly driven by end users and machine tool manufacturers from different markets. Laser and robot polishing offer potential to strengthen the European Tooling Industry by a significant decrease of polishing costs (75 %) and time (90 %). In 5 to 7 years this will result in expected annual savings of manufacturing costs for tools of 150 Mio. Euros and in reductions of the time-to-customer by 27 to 45 %. The shorter time-to-customer will stimulate new demands. In conjunction with the decreased costs this will lead to a regain of world market shares and therefore relocation of labor back to Europe. poliMATIC will contribute to the transformation of the resource intensive tooling industry into a knowledge-based one.

The potential impact of automated polishing technologies is not limited to the tooling industry. The polishing technologies can be transferred to other industrial sectors in which polishing is widely used, for example:

– implants
– medical devices
– turbine components
– automotive parts
– mechatronical components
– valve units

Laser Polishing

Polishing with laser radiation is based on remelting a thin surface layer of the workpiece and smoothing of the surface roughness due to the surface tension. The innovation of laser polishing results from the fundamentally different active principle (remelting) compared to conventional grinding and polishing (abrasion). For metals usually diode pumped solid state lasers are used. A new developed CAM-NC data chain enables the polishing of complex shaped free form surfaces.

– Workpiece material: Well suited for laser polishing: 1.2343, 1.2344, 1.2379, 1.3207, 1.3244, 2.4668, 3.7164, among other metals

– Workpiece geometry: Automated processing of 3D surfaces; suitable also for complex shaped parts and small workpieces

– Surface quality: N5 to N3 according to DIN/ISO 1302 depending on the material and its homogeneity; polishing results independent of the workers skills

– Process time: 1 min/cm^2 (cw) to 0,1 min/cm^2 (pulsed); polishing time nearly independent of the geometry

– Highlights: No pollutive impact from grinding and polishing wastes; avoidance of contaminations of the material with abrasives; selective polishing of limited areas is possible.

Robot Polishing

The established abrasive finishing (e.g. grinding, lapping and polishing) process applied manually in the die and mould industry is aimed to be automated through the employment of a force controlled robot. Finishing with a robot leads to an encapsulation of the knowledge, skill and experience of the human worker within an automated solution. The approach consists of a force-controlled finishing spindle and a fully automated CAD/CAM-based task planning and enables the user to process freeform surfaces by a step-wise automated robot finishing.

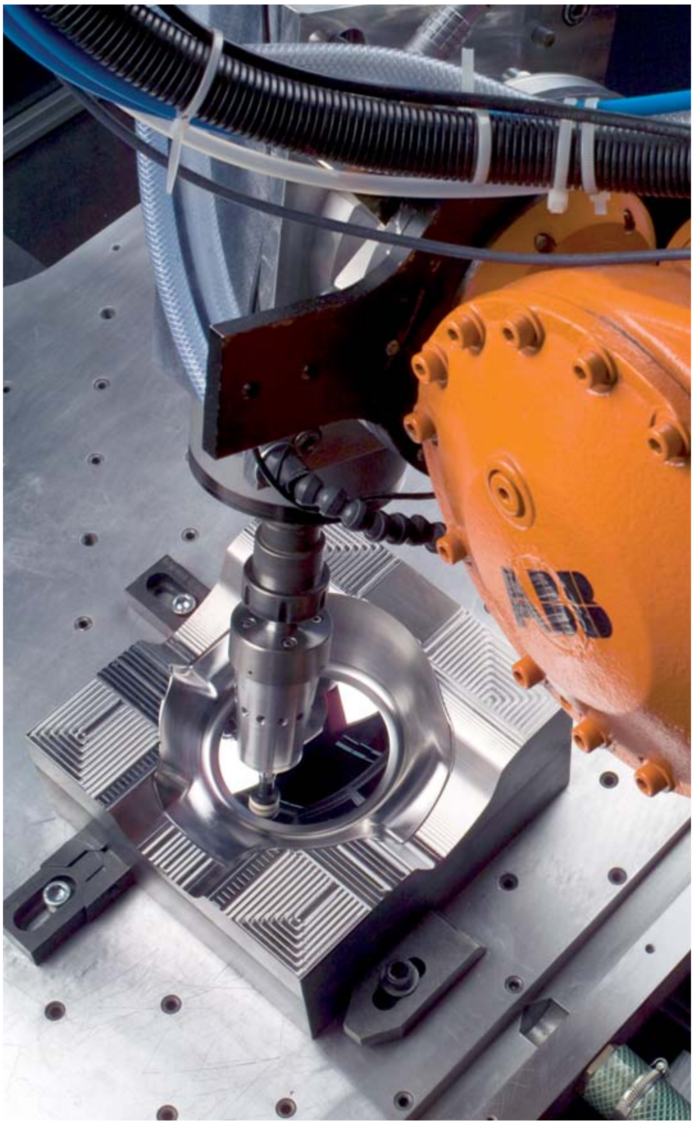
– Workpiece material: The project focuses on the finishing of steels applied in the mould an die industry (e.g. 1.2334 ESR, 1.2083 ESR), Nonetheless the technology is applicable to other materials (metals, ceramics, plastics, wood)

– Workpiece geometry: The solution is appropriate for medium-large workpiece surfaces (injection moulds from 50 to 1000 kg)

– Surface quality: Independent from previous machining, a wide range of surface qualities and textures are feasible from brush finishing up to glossy surfaces (N12 to N1 according DIN EN ISO 1302)

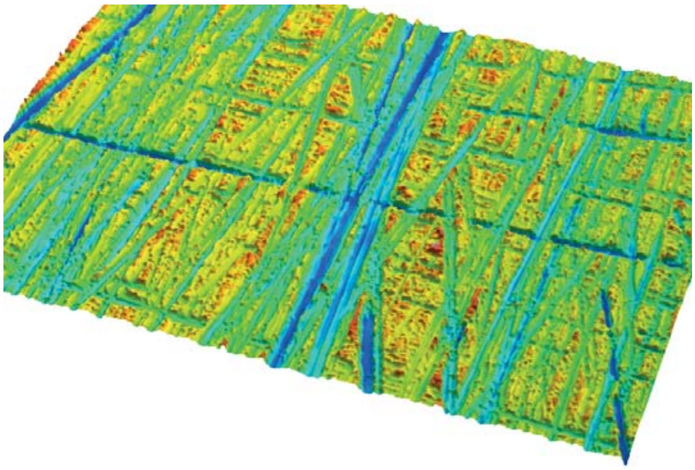
– Process time: Up to 10 times shorter than a manual polisher, offering a finishing process rate in dependence of the geometry and surface quality between 1 to 30 min/cm²

– Highlights: An industrial robot can imitate human kinematic attributes – with the advantage that it can perform the craftsman actions far more frequently and precisely. The hourly rate is equal or even less than the hourly rate of a manual polisher.



Metrology

In connection to the automated technologies, metrology framework for in-machining control for the laser as well as for the robot polishing system has been developed. Two complimentary methods have been developed to allow fast process feedback as well as final quality assurance. The integrated metrology systems will in the future allow an in-line uniform quantification for describing e.g. scratches, pull-outs or waviness on a surface and as consequence support the automated execution of the polishing process with topographical feed-back information.



– Measurement principles
  - Qualitative statistic measurements: Laser coherent scattering is used for fast process feedback.
  - Quantitative detailed measurements: Confocal chromatic probe is used for mapping of surface features.

– Standards for characterization
  - Qualitative statistic measurements: Characterization works towards the technical norm "VDA 2009 Geometrische Produktspezifikation" for a fast qualitative feedback loop to the process.
  - Quantitative detailed measurements: Characterization uses ISO 4287:1997 profile parameters and ISO 25178-2:2011 areal parameters, as well as 25178-602:2007 (probe type) for the hardware.

– Measuring time
  - Qualitative statistic: 100 mm^2/s measuring spot (scannable over large areas)
  - Quantitative detailed: 10 to 50 mm/s traversing speed in a volume of 25 x 25 x 25 mm^3. Sensor vertical range (and resolutions) are 100 µm (5 nm) and 400 µm (15 nm).

– Highlights
  - Qualitative statistic measurements: Enable fast characterization of the whole polished part with information of the specular and diffuse reflected laser light statistically related, e.g. Sq (rms surface amplitude) and Str (Symmetry of structure), to the polished topography and lay directions.
  - Quantitative detailed measurements: The non-contact confocal chromatic probe point scanning of the polished surfaces allow a feedback of traditional known profile topography like Ra (average amplitude) and novel areal parameters characterizing the surface features like scratches, peaks and defects in detail.

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