InPUT

Inline process monitoring of forming processes using tribological systems

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Department	Tribology
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Abstract

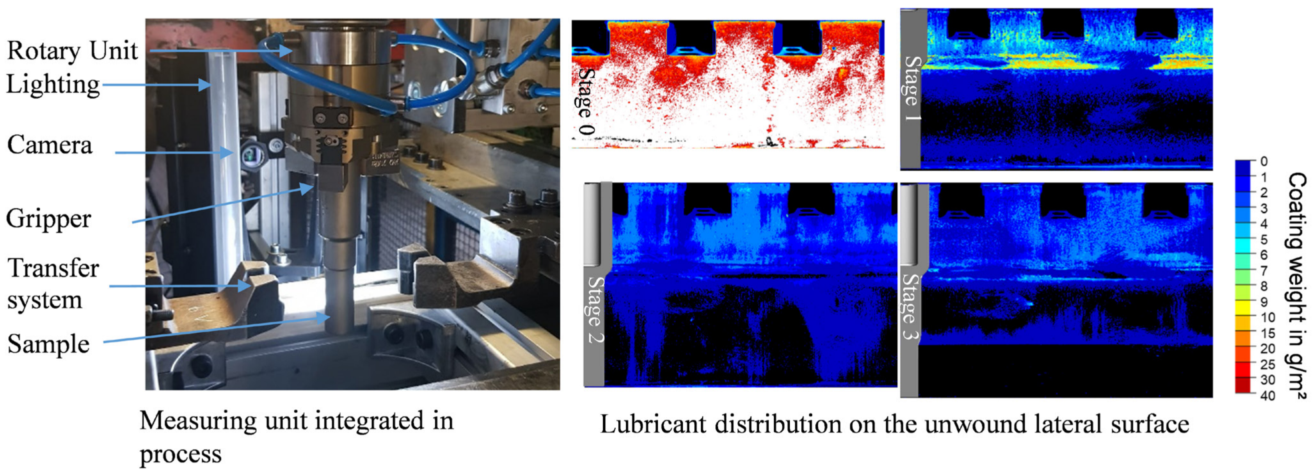
The aim of the research project is to develop an inline-capable in-situ process monitoring system for temperature and lubricant distribution in cold forging. Inline process monitoring is carried out by integrating UV and thermochromatic indicators into the lubricant, allowing the coating thickness and temperature to be recorded directly at the interface between the workpiece and the mould. With the help of process analytics, the lubricant and temperature distribution can be determined with local resolution and fed back to upstream and downstream processes.

Project description

At the beginning of the project, the indicators are selected and integrated into the lubricant and the indicator standardisation data sets are created for the subsequent measurements. At the same time, the process analysis is set up and integrated into the sample process. The process analysis consists of a measuring cell in which the component surfaces are optically recorded and the subsequent software-based preparation and provision of the measurement results. Tribometer tests are also carried out in parallel in order to investigate the influence of the integrated indicators on the lubricant behaviour (or to rule out any interaction). The project concludes with the testing of the measurement technology on a sample process in an industrial environment.

Results

As part of the project, a methodology was developed to record the lubricant layer thickness and distribution as well as the lubricant temperature. The measurement sensor technology is based on the integration of thermochromic and fluorescent indicators in a salt-wax lubricant. In a first step, suitable indicators were identified and integrated into the lubricant. In addition, the measurement sensor technology was transferred to other lubricant systems. Subsequently, test methods for calibrating the measurement sensors were developed in the laboratory and standardised data sets were created. A heating unit was developed for the targeted temperature control of the calibration samples, with which samples can be heated up to 500 °C within one second. An integrating sphere was developed and successfully used for the calibration of fluorescence indicators. Based on this, a process analysis was designed and integrated into an industrial sample process (Figure 1). Due to the installation space available in the industrial environment, a measuring system with a line scan camera was developed and characterised. The setup was then integrated into the sample process and synchronised with it so that continuous recording of the lateral surface was possible during continuous operation of the sample process. Finally, the results obtained were analysed. The heavy thinning of the lubricant poses a challenge, as a missing lubricant layer is synonymous with a missing sensor (Figure 1). To compensate for the thinning and failure of the



[1] Developed measuring unit and lubricant thinning in a multi-stage processs

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lubricant, modifications to the semi-finished products and the process were investigated. The methodology developed offers potential for investigating further causal relationships, particularly in the area of coating thickness measurement. In fully automated systems with inline lubrication systems, it is also possible to transfer the data obtained on lubricant distribution to the coating and relubricate it depending on wear. The measurement technology developed is already being used in current projects and is intended as an additional analysis tool for future projects.

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