

Property-controlled freeform bending process

Property-controlled process design of free-form bending considering material properties of the semi-finished product

Motivation

The freeform bending machine is able to bend tubes and profiles of various radii without any tool change. The biggest advantage of the freeform bending with movable die is the seamlessly connection of different radii in one part. Particularly suitable areas of application for this machine are those involving work pieces of different sizes with large radii.



Figure 1: 6-axis-freeform bending machine.

The principal objective of the proposed research project is the development, flexibilization, and industrial implementation of a property-controlled freeform bending process. In addition to the control of work piece geometry, its mechanical properties (e.g. strength, ductility, grain size distribution and residual stress) will be influenced during forming.

Approach

The central innovative idea of this proposal is the development of a model-based closed-loop control system, which consists of process-parallel soft sensors and physical or empirical models. This system enables process monitoring before and after forming as well as control of mechanical properties, which are difficult to register directly. Especially innovative is the model-based inline monitoring of mechanical material properties via force sensors at the bending instrument,

acoustic emission sensors, and micro magnetic sensors. A further innovation of the proposed project is an adjustable heating of work piece before the forming step and process integration into a robust monitoring and control system. These tasks require a cooperation of three applicants from the domains of material engineering, control theory and production engineering. The primary objective of the first phase is the demonstration of process controllability. It is done on a basis of a freeform bending machine in combination with a closed-loop control system and inline evaluation capabilities, which shall be developed, specifically for this project.

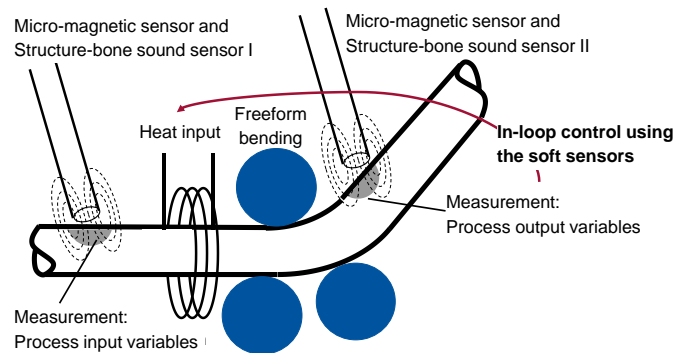


Figure 2: Schematic representation of the overall concept.

Conclusion

The measurement, use and control of local component properties through the massive use of measuring and material technology, control systems and process engineering leads to a paradigm shift in the design of the freeform bending process.

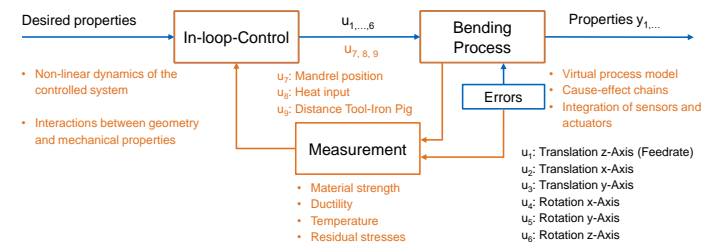


Figure 3: Final property-controlled process design of freeform bending.