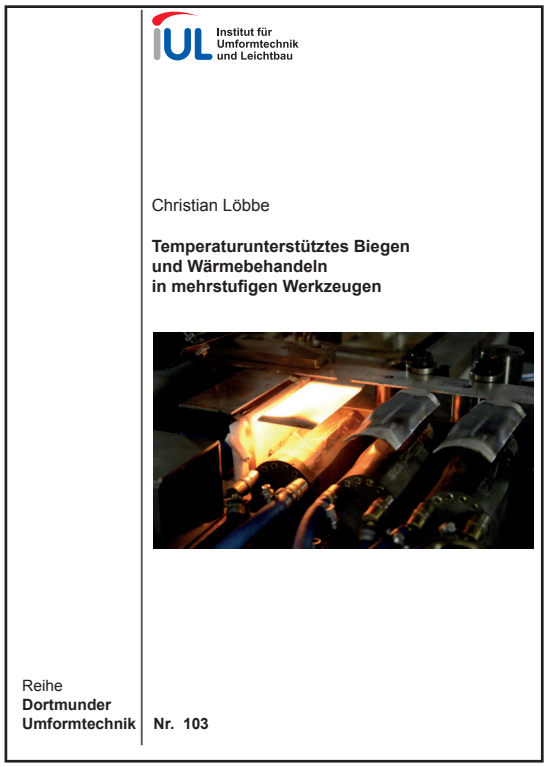
English version below

Institut für Umformtechnik und Leichtbau

Temperaturunterstütztes Biegen und Wärmebehandeln in mehrstufigen Werkzeugen

Christian Löbbe



Reihe Dortmunder Umformtechnik - Band 103

Shaker Verlag

ISBN: 978-3-8440-6485-8

Sprache: Deutsch

Zusammenfassung

The key for manufacturing resource-saving sheet metal components is the simultaneous forming and heat treatment. The combination facilitates the production of complex geometries and customized product properties. While hot stamping is an established technology based on this principle, the transferability to further applications is limited due to the high investment costs, the low flexibility and the limited productivity.

Hence, for the general application of heat-assisted sheet metal forming the process fundamentals of a recently introduced technology are investigated. The development is dedicated to the broad usage of conventional multi-stage forming processes such as progressive- and transfer-tool-technologies, which are enhanced by a targeted heat supply. For enabling the thermal processing inside the forming process, the technology is initially extended in terms of the rapid inductive heating and multi-stage heat removal.

Furthermore, the mechanisms of heat assisted bending are investigated, which is selected as a representative forming process. In air-bending process, overbending is an additional parameter beside springback, to control the bending result, which depends on temperature, punch speed and geometric parameters. In die-bending, thermal contraction is a mechanism that facilitates a stress superposition and calibration of the bent angle similar to stretch bending. For the process analysis, the complex mechanisms are each covered by a semi-analytical and an analytical approach, which simplifies the application in a closed loop process control.

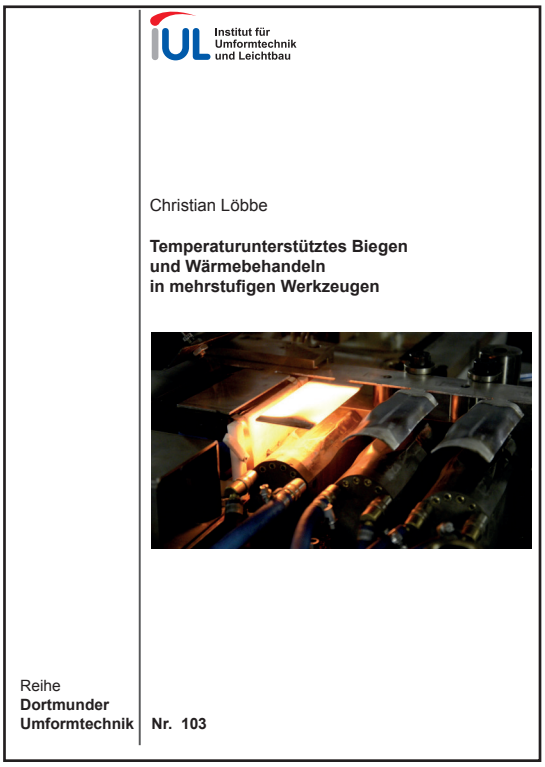
Moreover, to conduct a rapid heat treatment of low alloy steels, the relevant process steps were analyzed and modeled by semi-analytical relationships. For controlling the tensile strength or hardness, in addition to the grain size, the carbon content is an actuating variable. These parameters are adjustable by means of austenitization, homogenization and annealing, as well as quenching. The modeling finally facilitates the determination of process parameters for the martensitic transformation, as well as estimation of the resulting properties.

Finally, case studies show the application of the investigated technology either for manufacturing dimensionally accurate components in a warm bending process or for producing components with a defined hardness in a hot forming process. The work reveals a development based on the conventional technologies for multi-stage sheet metal forming through a targeted heat assistance. Hence, the solution enables the development of emerging markets by producing complex shaped sheet metal parts with tailored properties.

Institut für Umformtechnik und Leichtbau

Temperature-assisted bending and heat treatment in multi-stage tools

Christian Löbbe



Series: Dortmunder Umformtechnik - Volume 103

Shaker Verlag

ISBN: 978-3-8440-6485-8

Original language: German

Abstract

The key for manufacturing resource-saving sheet metal components is the simultaneous forming and heat treatment. The combination facilitates the production of complex geometries and customized product properties. While hot stamping is an established technology based on this principle, the transferability to further applications is limited due to the high investment costs, the low flexibility and the limited productivity.

Hence, for the general application of heat-assisted sheet metal forming the process fundamentals of a recently introduced technology are investigated. The development is dedicated to the broad usage of conventional multi-stage forming processes such as progressive- and transfer-tool-technologies, which are enhanced by a targeted heat supply. For enabling the thermal processing inside the forming process, the technology is initially extended in terms of the rapid inductive heating and multi-stage heat removal.

Furthermore, the mechanisms of heat assisted bending are investigated, which is selected as a representative forming process. In air-bending process, overbending is an additional parameter beside springback, to control the bending result, which depends on temperature, punch speed and geometric parameters. In die-bending, thermal contraction is a mechanism that facilitates a stress superposition and calibration of the bent angle similar to stretch bending. For the process analysis, the complex mechanisms are each covered by a semi-analytical and an analytical approach, which simplifies the application in a closed loop process control.

Moreover, to conduct a rapid heat treatment of low alloy steels, the relevant process steps were analyzed and modeled by semi-analytical relationships. For controlling the tensile strength or hardness, in addition to the grain size, the carbon content is an actuating variable. These parameters are adjustable by means of austenitization, homogenization and annealing, as well as quenching. The modeling finally facilitates the determination of process parameters for the martensitic transformation, as well as estimation of the resulting properties.

Finally, case studies show the application of the investigated technology either for manufacturing dimensionally accurate components in a warm bending process or for producing components with a defined hardness in a hot forming process. The work reveals a development based on the conventional technologies for multi-stage sheet metal forming through a targeted heat assistance. Hence, the solution enables the development of emerging markets by producing complex shaped sheet metal parts with tailored properties.