Faculty of Electrical Engineering & Computer Science
Master Degree Course Electronics Engineering, MSc EE

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Strain Rates at Laser Beam Bending using High Velocities.

ABSTRACT - Masterthesis

Laser utilization in sheet metal working promises benefits in terms of working accuracy and application flexibility. An example is the laser beam bending. In this process the forming effect origins from thermal stresses, which occur because of direction-specific resistance of material due to inhomogeneous heat distribution and therefrom concluding presence of temperature gradients. With laser power increased to a sufficient level the material is forced to yield loyalty favouring the direction of lowest resistance. After cooling down a forming effect can be observed. Due to the process complexity and its incremental character (multiple passes) the identification of suitable process parameters requires a considerable planning effort by the trial-and-error method. Preliminary investigations gave credibility to a simulation based semi-static modeling approach of laser energy coupling in case of parameter configurations distinguished by fast velocities and/or low thermal diffusivity of the material. These time constants are expected to be strongly related to the occurring strain rate, which in turn is assumed to be decisive for a simulation model to be dependent on the aspect of transience.

The scientific goal of this master thesis is to characterize the influence of selected process parameters on occurring strain rate during laser induced sheet metal bending at high velocities. A distinction is to be made regarding the warm-up and cooling-down phase. The bending process should take into account multiple irradiation passes. Parameters to be varied in the experiments are: velocity, laser power and sheet metal thickness. The materials investigated shall be pure aluminium and stainless steel. Based on generated experimental results suitable material models are to be set up and used in a series of finite element method based simulations to gain insight on the occurring strain rates. The experimental work includes a parameter study and in-situ measurements on displacement and temperature behaviour for validation purposes.