High Performance Transfer Press for Precision Manufacturing of Micro Metal Parts: Micro Forming Technology, Precision Engineering

Micro forming technology has several notable benefits such as yielding remarkable accuracy, high production speed, material saving and good mechanical properties of formed parts which allows complex micro parts to be manufactured by this technology. There are also presses fabricated appropriately for this technology and are available already in the market. Similar to conventional forming processes, the presence of a handling system can significantly improve the efficiency of the technology towards building a high performance transfer press for micro forming technology. To examine this possibility, it is important to investigate the process parameters such as billet preparation, automation, forming machine and forming process which influence on geometrical accuracy and surface quality of formed parts. Previous studies have indicated handling devices for micro forming based on different strategies and handling concepts. The aim of this research primarily is to develop an integrated solution for micro metal forming based on a flexible tool with integrated handling operations. The study herein extends these finding by designing and implementation of a multi-step micro metal forming process based on the above developed handling solution including a fully instrumented flexible tool for micro metal forming with the above mentioned characteristics.

For this research, the 1050 Aluminum Alloy was used for forming material while it is originally in the form of coil. This original stock was sectioned into the necessary size for billet preparation. The analysis of the prepared specimens focused on establishing the effect the shearing process has on the precision of billet by examining the length and weight of sheared specimens. To observe possible defects on the cut edge, the sheared surfaces were tested for measuring the ovality of the sheared surfaces. An upsetting test was used to determine the flow stress curve of the material. Additionally, the initial condition of specimens were indicated for roughness and microstructure parameters.

A transport device was manufactured which consisted of a linear motor for actuation principle and mechanical grippers based on self-centering and friction principles. This study introduced a methodology for the analysis and characterization of this transfer system on component level and system level. Laser interferometry was used in combination with analytical models to predict the positioning ability of the actuator in a static as well as dynamic mode. In combination with an analysis of the grippers, a full description of the transfer precision inside the forming press was obtained.

The current research involved integration of a handling system into an existing developed micro press in order to maximize the output rate up to 250 strokes per minute without compromising accuracy. A thorough investigation of machine’s layout and electrical circuit was conducted by combining two drives with ejection system for the new development of high performance transfer press. A transfer study was carried out on the basis of optimal dynamic parameters for the press and the manipulator. Through the application of high speed camera, the effect of proposed mechanism was studied on the flow of process in order to ensure an automated production as fast and smooth as possible for uninterrupted motions.

Consequently, the capability of the newly developed machine tool was examined by implementing a proposed two-operation micro cold forging process. Empirical knowledge and developed methods were obtained for manufacturing optimal front profile of the grippers in respect to the geometry of forged parts in each forming operation. While introducing a two-step forming process, process parameters such as tooling material, forming force, surface roughness of forming tools, lubrication and material flow were investigated.

The work was concluded with a recent high performance transfer press for micro forming technology in which all operations are automatic: feeding and transportation of specimens, press force and stroke control, part ejection and extraction of finished parts as well as monitoring and control of the entire transfer press. The effectiveness of the machine was analyzed in conjunction with the dynamic performance of feed drive, off-center loading and elastic deflection while introducing the errors due to the tool wear and thermal behavior of the system. Finally, the machine tool proved to be successful with respect to the concepts applied to the whole system for automatic production.