

## Theoretical and Experimental Investigation of Viscous Pressure Forming for Manufacture of Miniature Parts

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### Summary

Viscous pressure forming is used for production of thin sheet metal parts. In this work gold, silver, aluminium and copper sheets are successfully and accurately formed into complex parts. Affecting parameters such as sheet thickness and distance between sheets and forming die are investigated on parts quality. Stress distributions in system's components are obtained by FE method. Accuracy in the product is measured by non contact image processing method. Although the applied mechanism is very simple however measurements of parts and forming die reveal that the accuracies in products are excellent.

### 1. Introduction

Industrial demands on miniature products with high accuracy and complex shapes are increasing. The demand of miniaturization comes not only from consumers, who are wishing more handy electronic devices and more integrated functions, but also from technical applications like medical equipment, sensor technology and optoelectronics [1, 2]. All these products contain mechanical parts such as levers, connector pins, resistor caps, screws, contact springs and chip lead frames [2]. Several non-traditional techniques have been proposed for low volume production of complex miniature parts with high accuracies [1, 2]. Viscous pressure forming (VPF) is a recently developed sheet forming process. VPF is very similar to conventional flexible sheet forming technologies, such as hydro-forming and mar (rubber) forming. In its simplest version, it can be thought of as a forming process where a highly viscous yet flowable semi-solid medium is used instead of water. Compared with the conventional sheet metal forming processes, the viscous medium can fill a complex-shaped surface very well. The parts formed by VPF have good surface quality and high dimensional accuracy [3]. Potential applications of VPF include prototyping and low-to-medium volume production of stretched or drawn sheet metal components, forming of hard-to-form strain sensitive materials, and scratch free forming of painted or coated sheets [1, 2]. In this paper it will be shown that viscous pressure forming a simple method for production of small features in low volumes. In this work, viscous pressure forming is successfully used to manufacture miniature parts with high accuracies. A viscous pressure forming apparatus is designed and manufactured. Tests are carried out in various conditions and effective parameters on parts quality are investigated. To check the dimensions of thin miniature parts, contact measuring methods such as CMM systems are not suitable. For this reason a non contact measuring method which is based on image processing is used. In the present work an ATOS system is used to obtain 3D cloud points of produced parts and also their forming die. Hence although the proposed VPF system is simple but image processed measurements show that it is up to a few microns accurate. Among the advantages of this proposed apparatus is its simple and effective sealing mechanism and also its air vent system by which air can be evacuated during the process.

### 2. Components of the VPF apparatus

In viscous pressure forming apparatus, a viscous medium is employed instead of a solid punch for generating pressure on one side of sheet metal. The experimental setup is schematically illustrated in Fig. 1 and also ground cylinder and piston which are used in this apparatus are shown. These have been made from hardened steel and ground with 2 microns accuracy.

In this apparatus, two pairs of V-Rings are used for effective sealing of pressure chamber and preventing leakage of the viscous fluid. To perform the test, the sheet metal is clamped between these