ROUNDESS MEASUSEMENT of MINIATUR COMPONENT

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ABSTRACT

Micro forming is an appropriate technology to produce miniature components because of high production rate and because it can create 3D features. A number of technological barriers must be overcome for micro forming to be applied in the production of metallic miniature components. One of these barriers is dimensional measurement for product quality inspection. In this study cold headed miniature part was produced by micro forging experiments. The experiments were aimed at considering the effects of forging load and annealing process on product quality of cold headed miniature part. Since the cold headed miniature part has circular form, the measurement of out-of-roundness is an important assessment. The roundness of products was measured by coordinate measuring machine (CMM) and dial indicator. The experimental results show that annealing process and forging load have a significant effect on roundness.

Keywords: Roundness measurement, micro forming, miniature components

1. Introduction

The Miniaturization is the central theme of modern fabrication technology, as many of the components used in modern products are becoming smaller and smaller. The miniaturization of products has many inherent benefits, including a reduction in energy consumption, portability and improved performance and efficiency by taking advantage of the scaling of physical properties [1,2]. The micro products have been widely used in the past few years and have been used in electronics, mobile phones, computers, sensor technology and medical equipment [3]. All these products contain mechanical components such as leverages, connector pins, resistor caps, tiny screw, contact and chip leadframes, and most of them are metallic components. To produce metallic micro-components, micro forming is an appropriate technology to efficiently produce large numbers of metallic micro-components at low cost and micro forming possesses an advantage edge in term of high production rate, 3D features, minimal or zero material loss, excellent mechanical properties of the product, small tolerances and a wide range of materials [4]. Thus, metal forming technologies become more and more established in the production of micro parts and lots of research is currently done in this field [4].

Recently, millions of micro screws are produced through upsetting and rolling of wire pieces of 0.8-1 mm diameter every year [4]. Cold headed parts can be formed in same dimensions and with special machine equipment even down to wires of 0.3 mm in diameter. Kang et.al, had success to produce an equipment to investigate the superplastic material of Al 5083 [5]. They concluded that micro-formability is closely related to the number of grains involved in micro-forming. The grain size of micro-formed materials should be reduced as the pattern size to be formed decreases.

The application of metal forming technologies to the production of metallic micro-components is limited by problems arising from size effects related to these small dimensions, including dimensional measurement. In this study, cold headed miniature part was produced by micro forging process. The evaluation of geometric product specification is one of the most critical task to be accomplished for product quality assurance. Since the cold headed micro part has circular form, the measurement of out-of-roundness is an important assessment. The roundness of products was measured by coordinate measuring machine (CMM) and dial indicator.

2. Experimental Procedure

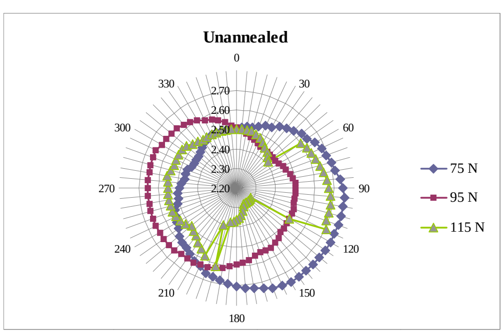
In this study, all forming experiments were conducted on an micro forming machine (see Fig. 1). The experiments were aimed at considering the effects of forging load and annealing process on roundness.

A set of micro dies was fabricated by electro-discharge machining (EDM) process. A small cylindrical specimen (diameter 1.5 mm, height 5.06 mm) was made by cutting an aluminium wire. In order to evaluate the effect of heat treatment process on roundness, some specimens were heated to a temperature 345^{o} C by a furnace , held at that temperature for 30 min and cooled in air to room temperature. All workpiece specimens were subjected to compressive load by controlling weight. The applied load were selected in the range of 75 - 115 N. The roundness of miniature parts was measured using a coordinate measuring machine (CMM, Mitutoyo QM-Measure 353) and dial indicator.

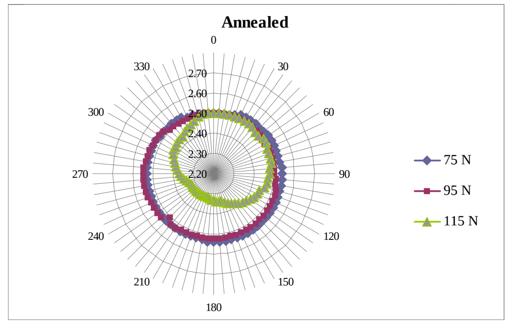
Fig. 1. Microforming machine

3. Results and Discussion

Figures 2(*a*) and *(b)* show the roundness profile using the dial indicator. These figures shows the effects of annealing process on roundness. It indicates that annealed specimen has better roundness than unannealed specimen.



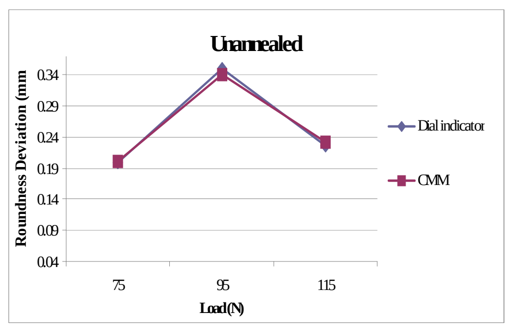
(a)



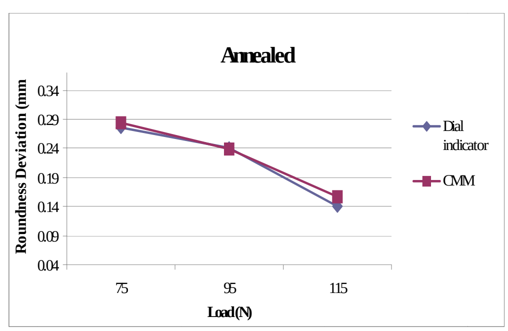
(b)

Fig. 2. Roundness Profile of: (a) Unannealed Specimens and (b) Annealed Specimens

The variation of roundness total with forging load are shown in Figures 3(a) and (b). The roundness was measured by CMM and dial indicator. The number of points measured by CMM and dial indicator are 8 and 12 respectively. It is shown that the results have no significant difference between CMM and dial indicator as roundness measurement equipment in this study.



(a)



(b)

Fig. 3. Roundness Total of : (a) Unannealed Specimens & (b) Annealed Specimens

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In Figure 3(b), it is seen that annealing process has significant effect on roundness. It is also seen that forging load has direct proportion to the roundness total, that is, by increasing forging load, the roundness total decreases significantly. It is well known that annealing process will decrease the grain size and grain size may affect the microformability. The deformation of polycrystalline metals occurs by grain boundary sliding [5]. By increasing forging load, it is easy for small grains to flow into the corner tip of upper die in all direction.

On the other side, Figure 3(a) implies that an optimal forging condition must be selected from the experiments. The optimal forging condition in this study was achieved when forming under low forging load.

4. Conclusions

The effects of forging load and annealing process on roundness were experimentally investigated in this study. The experimental results show that annealing process and forging load have a significant effect on roundness. Meanwhile, using CMM and dial indicator to measure roundness has no significant difference in this study.

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