Fast Tool Servo 이용한 roll to roll 가공특성 평가

Characteristics of Roll-to-roll Machining Using Fast Tool Servo

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1. Introduction

Roll-to-Roll manufacturing process is a continuous mode of production which is high efficiency and low cost. It is suitable for the continuous output of micro patterned structures and is not accompanied by waste produced during the processing.

This paper presents the design and machining test of a fast tool servo (FTS) that used for producing micro patterns at roller of the roll to roll embossing or the printing process.

Nowadays, the FTS technique used widely in the free form surface machining. Compare with the traditional manufacturing, the free form features in the past are produced by milling and subsequent grinding, which result in high cost and lower productivity. With the advancement of the FTS technique, high bandwidth, high precision and no subsequent process are provided to the precision machining. In this work, a fast tool servo which primary natural frequency can reach up to 2000 Hz was designed for producing micro structure of roller. And all the turning tests were conducted with a roll machine. Experiments show that the diamond tool can be moved up to 1000 Hz without re-injected vibration in the machine structure and with a stroke of up to 14 μm.

2. Experiments and discussions

Assembly of the FTS and having completed the machining, a series of investigations were performed using the experimental setup to assess its positioning performance, as shown in Fig. 1. A function generator was used to generate wave form. These wave forms were output to the PI amplifier and then

Table 1 Specification of PZT actuator

PZT model	Stroke	Blocking Force	Capacitance
PZT (PI)	30μm	1000N	64nF

Table 2 Specification of amplifier

Amplifier model	Average output power	Gain	Output voltage
Amp (PI)	110W	100±1	3~1100V

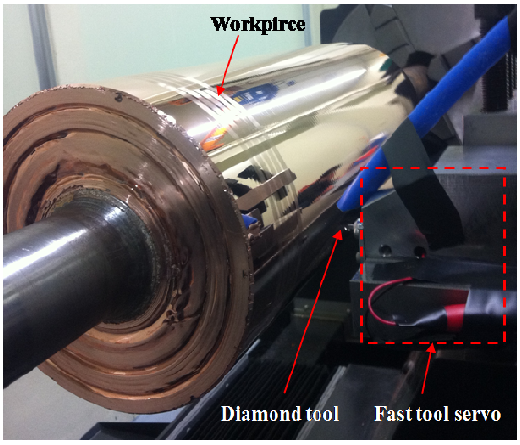

Fig. 1 Photograph of fast tool servo

supplied as drive signals applied to the PZT actuator. All the cutting tests were conducted with a roll machine.

Finally, the result shapes of the machined patterns were evaluated by the optical microscope and analysis the section profiles of patterns by the alpha step surface profiler.

Fig. 2 shows the patterns that produced with the different machining conditions. Fig. 2 (a) is machined with the FTS of 1000 Hz, the spindle speed of 50 rpm and the feed rate is set to 0.1 mm/rev. Fig. 2 (b) is generated with the FTS of 1500 Hz, the spindle speed of 75 rpm and the feed rate is same as the Fig. 2 (a) showed. However, the machined microstructures are depended mainly on two important factors: the spindle speed and the frequency applied to FTS. The patterns showed in Fig. 2 (a) and (b) possess the same pattern length (around 436 μm) that have great agreement with the calculate results.

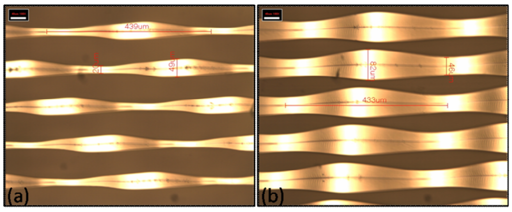

Fig. 2 Patterns with different machining conditions (a) 1000 Hz, 50 rpm; (b) 1500 Hz, 75 rpm

3. Conclusions

This paper present a prototype fast tool servo which primary natural frequency can reach up to 2000 Hz developed for the roll machining. The experimental results have shown that the output motion of the diamond tool follows driving signal more accurately, and the displacement of the diamond tool can be moved up to 1000 Hz without re-injected vibration in the machine structure and with a stroke of up to 14 μm.

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