하이브리드 가공을 위한 초음파 진동 구조물의 개발

Development of Fixture Apparatus for Hybrid Machining by Ultrasonic Vibration

*이상평 [1], #고태조 [1], 김민엽 [1], 김건 [1], 박종권 [2], 윤인준 [3]

*C. P. Li[1], #T. J. Ko (tjko@yu.ac.kr)[1] , M. Y. Kim[1], J.Kim[1], J.K.Park[2], I.J.Yoon[3]

[1] 영남대학교 기계공학과, [2] 한국기계연구원, [3](주)한국 OSG

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1. Introduction

Today's manufacturing industry is facing challenges from advanced difficult-to-machine materials (tough super alloys, ceramics, and composites), stringent design requirements (high precision, complex shapes, and high surface quality), and machining costs [1].The reasons for developing a hybrid machining process (HMP) are to make use of the combined or mutually enhanced advantages, and to avoid or reduce some adverse effects the constituent processes produce when they are individually applied[2].

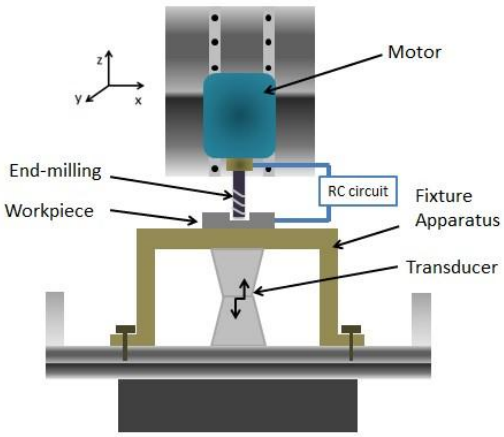

Fig. 1 Hybrid machining system

In recent years, there has been a rapid increase in the demand for micro-parts in the IT/BT/ST industry .The advantages of micro-milling machining complex 3D geometry and high processing efficiency have become an important micro-machining technologies. The micro-parts are very sensitive to ultrasonic vibration. Ultrasonic vibration assisted micro-drilling process can reduce the cutting heat and increase tool life[3] and improve the quality of the machined surface[4].

The purpose of this research is to develop a fixture apparatus for hybrid machining by ultrasonic vibration and also for electro discharge machining(EDM)-Milling, ultrasonic(US)-milling, EDM-grinding, US-polishing, etc. The fixture must keep the workpiece to the level , and pass ultrasonic vibration to the workpiece.

2. Design Requirements

This equipment mainly consists of the transducer(4545D-40HA, durasonic company) and the fixture apparatus.

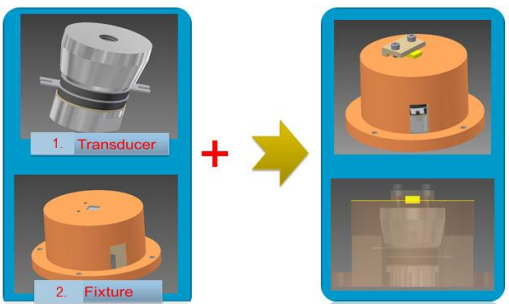

Fig.2 Fixture apparatus by ultrasonic vibration

The resonance frequency of the transducer shown in Fig.2(1) is 40kHzand the ultrasonic generator can produce the frequency between 1.5kHz to 100kHz. According to the formula below:

$$f = \sqrt{k/m} \qquad (1)$$

The weight of the device has been increased than

before. Therefore, the resonance frequency has been decreased, but not less than 1.5kHz. Therefore , it is necessary to improve the rigidity of the entire device. For every frequency range the fixture must have the same amount of displacement to vibrate the workpiece, or else the quality of processed Micro groove roughness will be reduced.

3. Analysis

Analysis of the resonance frequency and design optimization for the model was done by using ANSYS software

Table 1 Analysis of properties

Analysis		Modal(ANSYS)
Unit		Metric(kg, m, s, A, N, V)
Model Material		Aluminum
Material Properties	Young's Modulus	7e10 Pa
	Poisson's Ratio	0.33
	Density	2700 kg/m^3

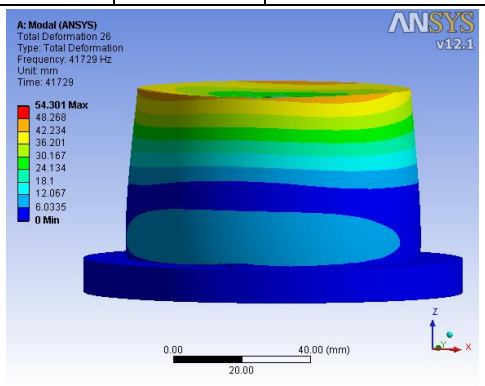

Fig. 3 Mode shape of model

Figure 3 shows the ANSYS model. the mode shape is the longitudinal vibration and the resonance frequency is 41729Hz.

In this research , a similar model was manufactured and the amount of vibration of the workpiece surface was measured using a fiber optic sensor.

4. Conclusion

The results of the vibration displacement of workpiece surface is shown in the Fig 4. The highest vibration displacement was noted when the frequency was 41010Hz. The error of results and ANSYS analysis only 1.7%.

In future work, We can do a lot of hybrid machining experiments on this machine. Two or more different processing methods can be combined.

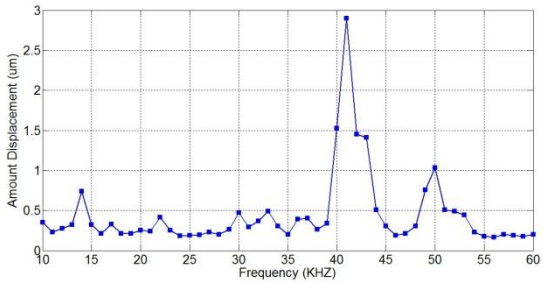

Fig. 4 Amount of vibration displacement of the workpiece surface

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