

Evaluation of Asymmetric surfaces by Femtosecond Laser Process for Microparts feeding

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1. Introduction

We previously showed that microparts can be fed along an asymmetric surface with simple planar and symmetric vibrations [1]. Microparts move in one direction because they adhere to the surface asymmetrically. In this paper, we tested the ability of asymmetric surfaces fabricated by the femtosecond laser process to feed 0402 capacitors (0.4 x 0.2 x 0.2 mm, 0.1 mg). Asymmetry of these fabricated surfaces was evaluated by measurements using an atomic force microscope. Using the results of feeding experiments of these capacitors, we assessed the relationship between driving frequency and feeding velocity.

2. Asymmetry of fabricated surfaces

We developed three surfaces, named **A**, **B**, and **C**, using a femtosecond laser processing tool, which consist of a shim tape, a stainless material 0.5 mm in thickness, 10 mm in width, and 30 mm in length. Figure 1 shows a picture of surface **A** taken by an atomic force microscope. Many periodic convexities are present on the surface of the material. By analysing these convexities of each surface, we obtained the surface profile (Figure. 2 and Table 1).

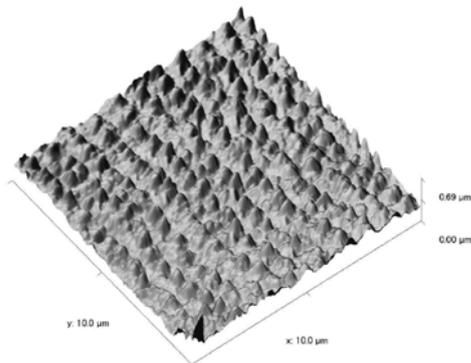


Fig. 1 Microphotograph of surface 'A'

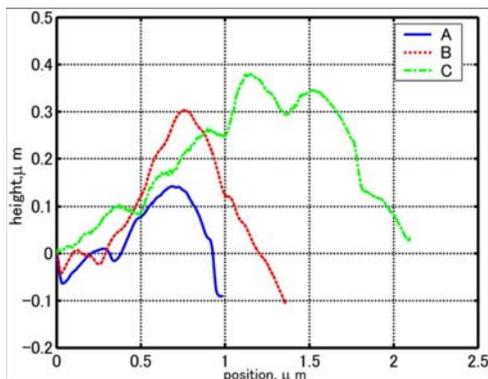


Fig. 2 Surface profiles of convexity on the surfaces.

Table 1 Surface profile parameters

sur-face	pitch μm	depth, μm	incline		duty %
			left	right	
A	0.92	0.17	0.43	-1.91	18.4
B	1.34	0.35	0.46	-0.60	43.4
C	2.05	0.38	0.29	-0.69	29.6

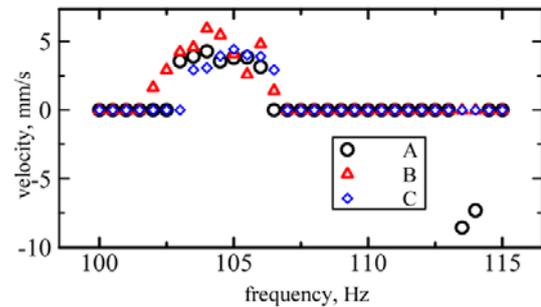


Fig. 3 Experimental results

3. Feeding experiments of 0402 capacitor

Using the fabricated surfaces, we performed feeding experiments of 0402 capacitors. At frequencies $f = 102.0$ to 106.0 Hz, microparts could be fed along on all microfabricated surfaces. The maximum velocity on the **B** surface at a frequency of 104.0 Hz was 5.9 mm/s, which could provide 888 parts per minute. When $107.0 < f < 113.0$ Hz, microparts did not move on any surface. At frequencies of $f=113.5$ and 114 Hz, only the **A** surface could feed microparts in the counter direction with feeding velocities of 8.6 and 7.3 mm/s, which could provide 1285 and 1098 parts per minute, respectively. This finding suggests that the movement of microparts is dependent on driving frequency using the **A** surfaces. For example, microparts move in the positive direction when the driving frequency is set to 104 Hz, whereas they move in the negative direction when $f = 114$ Hz and stop when $f = 108$ Hz..

4. Summary

We assessed microparts feeding using fabricated surfaces generated by femtosecond laser process. Future studies will include study of the tribology characteristics of developed surfaces using friction testing tools.

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5. References

- [1] Mitani, A. and Hirai, S., "Submillimeter Micropart Feeding Along an Asymmetric Femtosecond-Laser Microfabricated Surface," Int. J. Automation Technology, 3, 2, 2009, 151-156.