Worldwide R&D

Research on Technologies for Utilizing Miniature Device

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Shonan Institute of Technology is a university with an engineering faculty (five departments) and a graduate school (three specializations) and approximately 2,500 students. I am affiliated with the Mechanical Engineering department and graduate school specialization. My laboratory deals with technologies for utilizing miniature mechanisms, which do not require very large-scale equipment. We conduct research on the element technologies of microfabrication machines, high-speed lathing of microparts, micro generators, and the like. Here, I will describe two of these research projects.

(1) Direct-driven device with built-in actuator

We are studying direct-driven devices driven by friction. An actuator is integrated in the device for use in microfabrication equipment. We have verified the usefulness of these devices in a microlathe, which we developed earlier, and are currently analyzing the device properties in detail.

Fig. 1 shows the basic structure of the device, wherein two piezoelectric elements intersect a slider. Fig. 2 shows the results of an experiment for finding the relationship between the surface pressure and velocity of the slider, while varying the slider's thrust. From this experiment, we determined that thrust decreases the slider velocity, but a thrust of 10 N or less is possible when the slider surface pressure is approximately 150 kPa.

(2) High-speed lathing of microparts

When microparts are processed on a normal lathe, the cutting speed decreases, increasing the roughness of the processing surface dramatically. In a lathe experiment using a high-speed small-diameter spindle (manufactured by NSK Ltd.), we proved the effects of increasing the speed of the spindle on improving the lathed surface.

Fig. 3 shows the condition of the surface of brass after lathing the piece to a diameter of 100μm. Deep striation and the like observed when using a spindle rotational speed of 2 x 10^4 rpm did not appear when the speed was 16 x 10^4 rpm.

Fig. 4 shows the relationship between the rotational speed of the spindle and the arithmetic average roughness (Ra) of the lathed surface. A remarkable improvement in surface roughness occurred at a rotational speed of 4 x 10^4 rpm (a lathing speed of 13 m/min) or greater, while a Ra value of approximately 20 nm was obtained at 16 x 10^4 rpm. These results indicate that microfabrication devices capable of achieving high spindle speeds are effective in improving the processing surface.

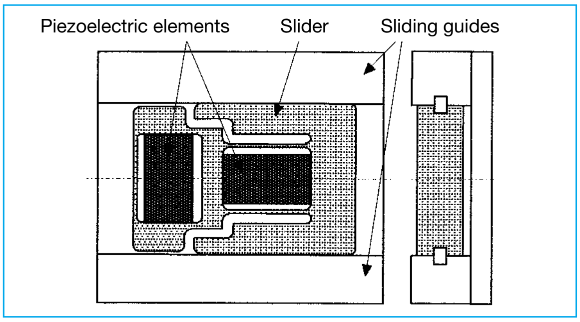

Fig. 1 Construction of a direct-driven device

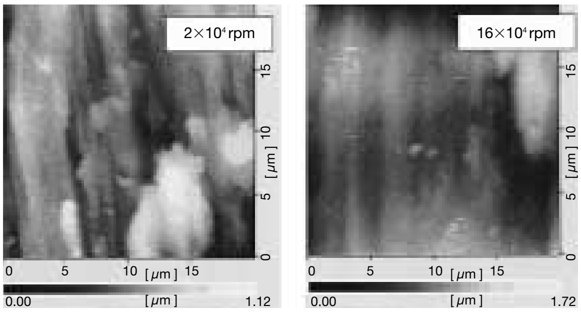

Fig. 3 Topography of the lathed surface

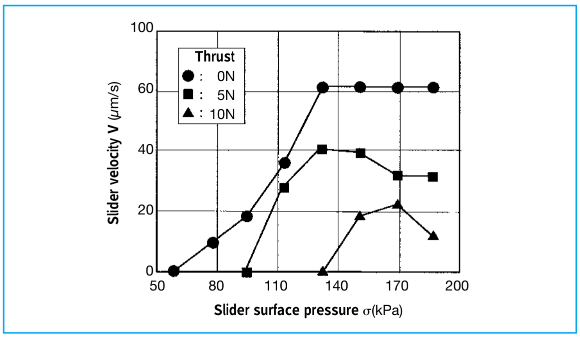

Fig. 2 Properties of the direct-driven device

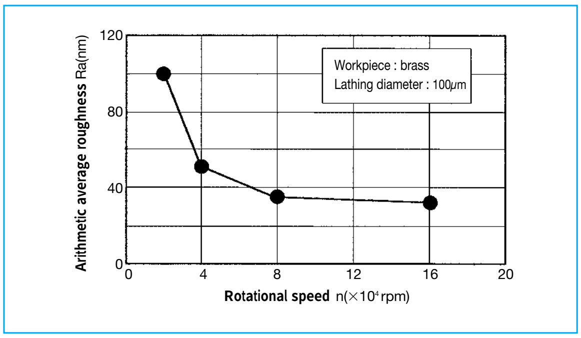

Fig. 4 Characteristics of high-speed lathing

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