Equipment Development Center

IX-Y Development of New Instruments and Experimental Devices

The technical staff of the Equipment Development Center is partly engaged in planning, researching, designing and constructing high technology experimental instruments in collaboration with the scientific staff. And these experimental instruments are incorporated with new manufacturing technology and new mechanical idea.

IX-Y-1 Development of a High-Precision Slit Blade for the Transmission-Grating Spectrometer

KONDO, Takuhiko; SUZUI, Mitsukazu; TORII, Tatsuharu[1]; MASUDA, Tadashi[1]; HORIGOME, Toshio; HATSUI, Takaki
([1]Nagoya Univ.)

Development of the transmission-grating spectrometer for soft X-ray emission spectroscopy has been carried out by the Department Vacuum UV Photoscience.

In order to improve further the energy resolution of the spectrometer, an entrance slit with the minimum slit opening of 1mm has been developed. In order to maintain the spectrometer efficiency, the distance between the sample and the slit is designed to be less than 1 mm. Accordingly, the slit blades are to be smaller than 13 × 10 × 2.5 mm^3. These requirements demanded a development of slit blades with a roughness of less than 0.3 μm using a high-precision polishing process.

The blades were polished first on the side A and B (Figure 1). The resulting roughness was less than R_a 7 nm. The edge surfaces were polished by using a clamp as shown in Figure 2. The four blades were pressed by the two plates via two screws (M4) so as to minimize the gap between the blades. The pressure was optimized so that the pile up did not occur during the polishing process. The resulting slit blade is shown in Figure 3. Figure 4 is the top view of the slit blade from A side. The edge roughness was about 0.3 μm.

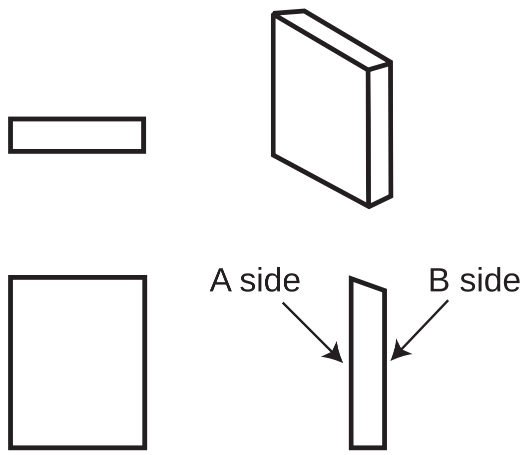

Figure 1. Schematic view of the slit blade.

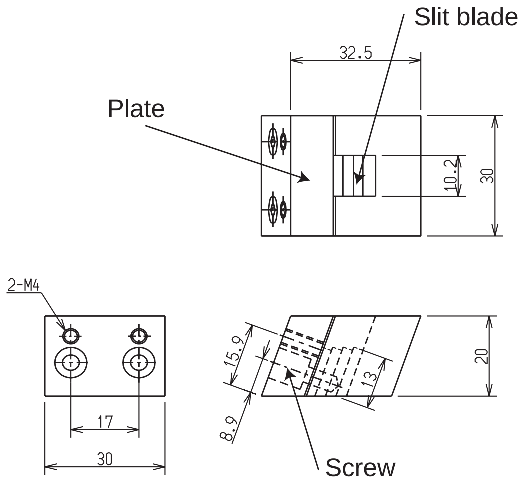

Figure 2. The clamp for the polishing of the edge surfaces.

Figure 3. Photograph of the slit.

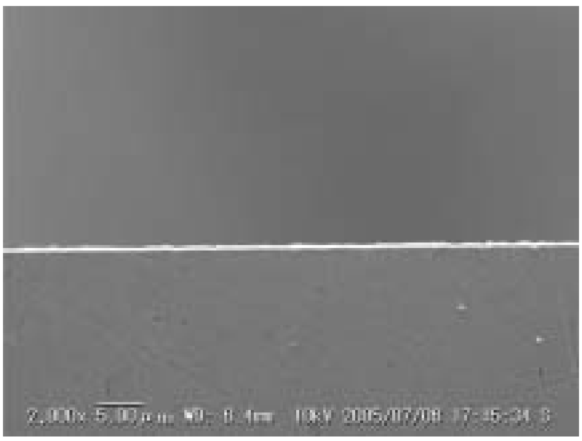

Figure 4. Top view of the slit blade observed by SEM.

IX-Y-2 Manufacture of Glass Microreactor Chips

AOYAMA, Masaki; SUZUI, Mitsukazu; FUKUYAMA, Naoshi; YAMADA, Yoichi M. A.; UOZUMI, Yasuhiro

Glass microreactor chips used for catalyst research in Research Center for Molecular-scale Nanoscience were manufactured.

Although glass chips are usually manufactured by photolithography and wet etching, it takes expense and time to manufacture many arbitrary flow patterns. Then, we attached the diamond grinding tool in the general machine tool, and processed flow patterns into it.

The SEM photograph of flow patterns of a chip is shown in Figure 1. The quality of the material was PYREX glass, and the slot width and depth were 100 μm and 40 μm, respectively. Although generating of the deficit of a detailed crack and edge could become a problem in processing of a brittle material, it was processed by spindle speed 50,000 rpm, feed rate 1.0 mm/min, the depth of cut 5 μm, and diamond tool particle size #1000, and good flow patterns whose processing side coarseness were about 1.5 μm were obtained.

Such processing technology is applied to processing of brittle material such as silicone in addition to glass, and is useful also to manufacture of the micro parts for Department of Vacuum UV Photoscience.

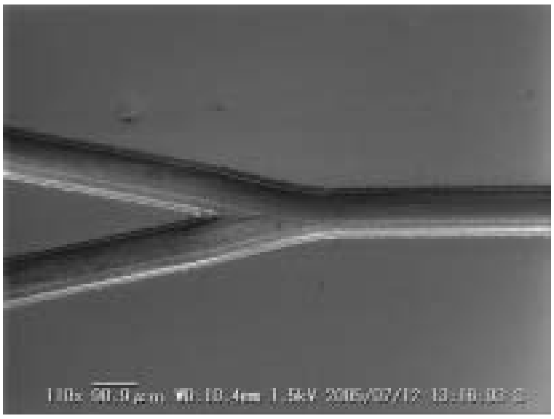

Figure 1. Flow patterns of a chip.

IX-Y-3 Micro Processing by a Femto-Second Laser

AOYAMA, Masaki; YANO, Takayuki; SUZUI, Mitsukazu; SASAKI, Ryuichiro[1]; NAGAI, Hiroyuki[1]; YOSHIDA, Makoto[1]; TAKAHASHI, Kazuyuki; KOBAYASHI, Hayao; RAHMAN, Md. Mashiur; URISU, Tsuneo
([1]AISHIN Seiki Co., Ltd.)

Micro fabrication processing was done by using the femto-second fiber laser (FCPAμJewel B-250) manufactured by IMRA in laboratory of AISHIN Seiki Co., Ltd.

Processing conditions are center wavelength 1560 nm, pulse width 900 fs, and repetition frequency 256 kHz. The main two cases are described in the following.

Diamond Anvil Cell for the high pressure experiment will be used by Department of Molecular Assemblies. In order to draw four probes out of the sample cavity of Diamond Anvil Cell, the groove for the wiring on the metal gasket of Diamond Anvil Cell is necessary. Schematic view of the metal gasket for the high pressure experiment is shown in Figure 1. The hole is at the center of gasket plate ($8 \times 8 \times 0.3$ mm^3 Inconel 625) and a diameter of 0.4 mm. Prepressing between both sides of the plate by Diamond Anvil resulted in the basin-like plastic deformation of the whole plate and a height of about 20 μm of the swelling around the central hole. In order to pass through the wiring with a diameter of 10 μm, the required groove width and depth are considered to be about 50 μm and 30 μm, respectively.

Excellent groove processing was attained in a short term with no heat effect on the sharpness of the edge and no deposition by melting. This result is shown in Figure 2.

It was applied to hole processing for the biosensor device used in Department of Vacuum UV Photoscience. An AFM measurement after hole processing is shown in Figure 3. Drilling of the Cobalt layer on SiO_2 with a diameter of about 1.5 μm could be achieved by adjusting laser power and an exposure time.

A trial of the partial removal of a gold thin film from a circuit pattern on the SiO_2-covered silicon substrate by the femto-second laser is now in progress.

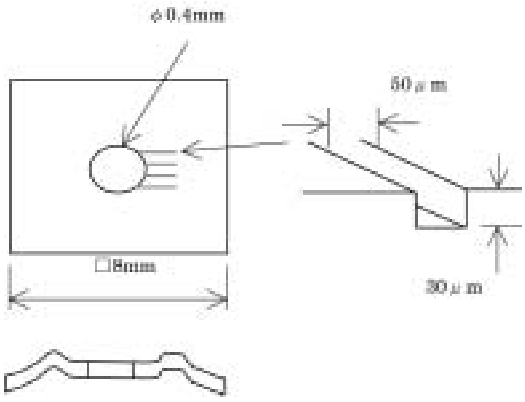

Figure 1. Schematic view of the metal gasket.

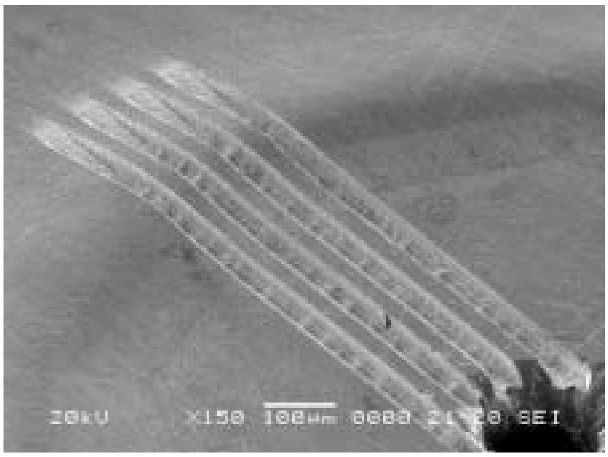

Figure 2.

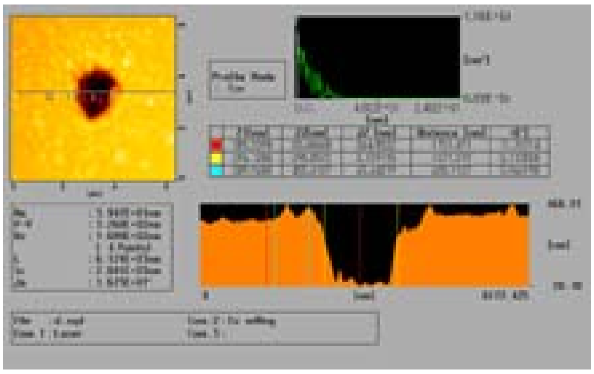

Figure 3. The measurement result of the cross section profile of a hole.

IX-Y-4 Development of Electrical Control System of Fluorescence Recovery after Photobleaching Apparatus Using Semiconductor Laser for Illumination

YOSHIDA, Hisashi; URISU, Tsuneo

We have developed the electrical control system of the fluorescence recovery after photobleaching (FRAP) apparatus as schematically shown in Figure 1. Two recording devices are equipped in the setup. One is a charge coupled device (CCD) by which the sample surface image and the photobleached spot image are monitored. The other one is photo-multiplier (PMT) by which the time dependence of the fluorescence intensity at the photobleaching spot can be monitored. A pinhole with 100 μm diameter is set at the confocal point of the microscope before the PMT. Two neutral density filters with different transmission coefficients are inserted to the filter holder to attenuate the UV lamp and laser intensities, respectively. The UV lamp illumination was used mainly for sample setting and was turned off during the photobleaching and the fluorescence recovery process. The photo-multiplier recording, which gives the time dependence of the fluorescence recovery directly, is very convenient in the calculation of the diffusion constant. The block diagram of a laser driving and the photo-multiplier detection system is shown in Figure 2. The semiconductor laser is drove by the bleaching pulse and succeeding pulse train of the sampling pulse.

The drive voltage 1.25 V correspond to the second harmonic output of ~5 mW. The fluoresecence recovery can be monitored by the weak sampling pulse train without giving damage to dye molecules. The relation between the laser driving pulses and the photo-multiplier output monitoring pulse are shown also in Figure 2.

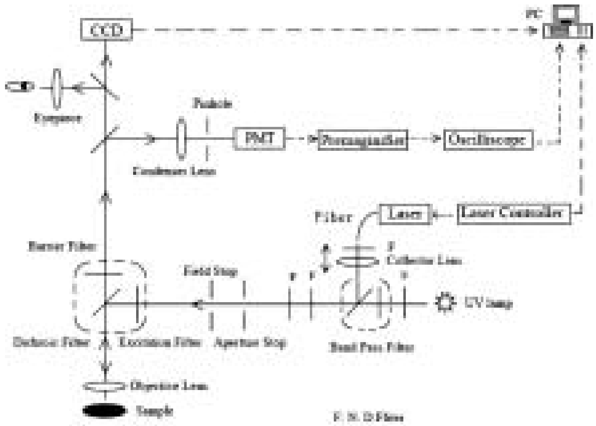

Figure 1.

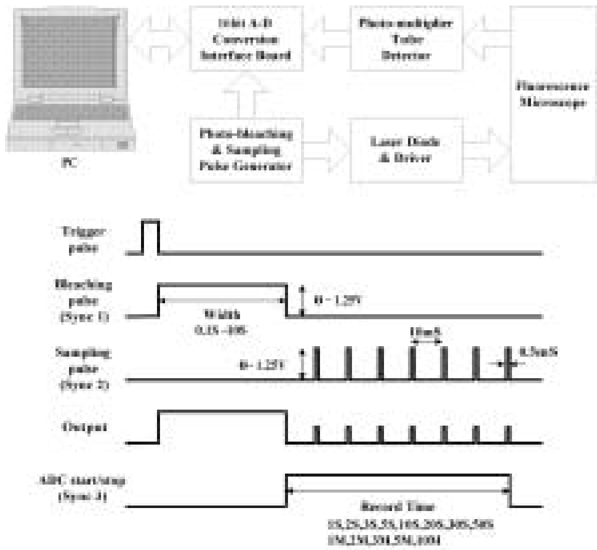

Figure 2.