극초단 펄스 레이저의 이광자흡수를 이용한 나노분해능의 3차원 마이크로 구조 제작

Three-Dimensional Microfabrication with Nano Resolution Using Two-Photon Absorption of Femto-Second Laser

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Stereo-lithography using the two photon absorption(TPA) makes micro structures with great resolution. The technique is applied to correcting photomask, 3-D photonic crystal, 3-D optical storage, 3-D lithography and so on[1]. In contrast to a conventional stereo-lithography with single-photon absorption which has a size problem caused by the geometrical diffraction limit, the stereo-lithography with TPA has no size limit. In the conventional method, the photo-polymerized resin[2] becomes solidified wherever the laser light illuminates as well. On the other hand, the resin is solidified only where the laser light is focused during the TPA stereo-lithography fabrication. With these remarkable advantages of the TPA stereo-lithography, S. Kawata, *et al.*[3][4] in Japan and A. Egbert, *et al.*[5] in Germany have achieved to construct the several micron sized 3-D structures whose voxel sizes are 120 nm and 200 nm, respectively. In this paper, we report the recent progress

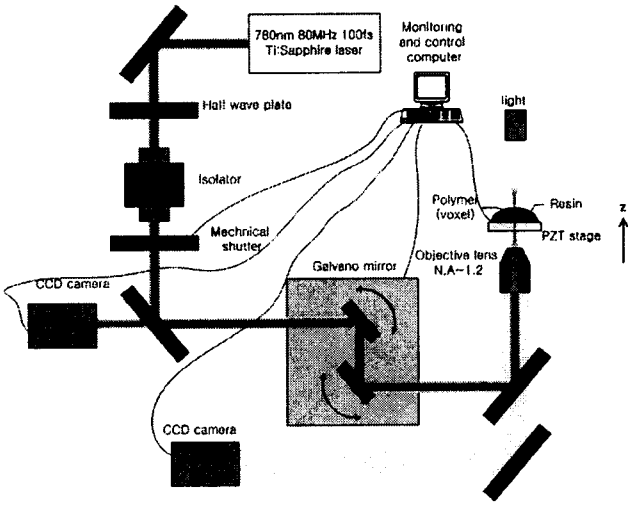

Fig.1 Scheme of optical system for micro-fabrication with two-photon absorption

of this technology in my laboratory.

The TPA transition rate proportional to the square of the incident light intensity is usually extremely smaller than the rate of single-photon absorption. Therefore it requires femto-second Ti: Sapphire laser which has high power about several kilo watts, whose pulse width is less than 100 fs. The TPA spatial distribution is much smaller than that of the single-photon absorption at some threshold. Furthermore, if a microscopic objective lens is used to focus a laser beam on the spot, very high photon density is localized in its focal spot.

Shown as Fig.1, we has set the TPA stereo-lithography system. Galvano mirrors and the mechanical shutter are used to move the focal position and control the exposure time for the voxel size, respectively. Moreover the resin which we used was a urethane acrylate resin. From the TPA stereo-lithography system, we wrote the letters, "KAIST" shown the below.

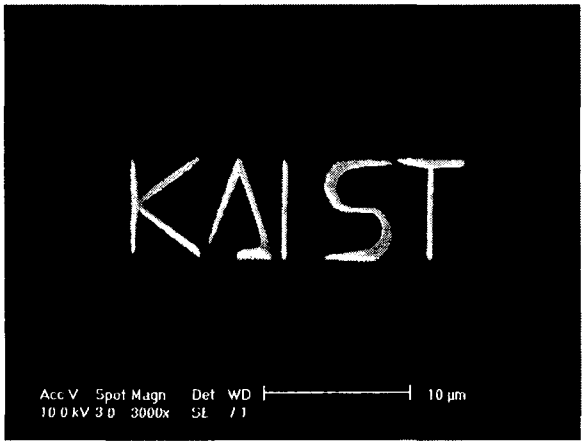

Fig.2 The letters, "KAIST" in sub-micro size

In addition to following up the frontier groups and producing sub-hundred nm sized voxel, we are planning to put the TPA techniques into practical uses such as micro diffraction lens, MEMS, and photonic crystal.

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