Study on surface excitation of SiC by double pulse femtosecond laser process ー Investigation of surface irradiation ー

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Abstracts: *Femtosecond laser irradiation excites semiconductor electron. Excited electron in the conduction band makes semiconductor absorb light more easily. We divided the one pulse to the two, and use one pulse for the semiconductor of excitation , using another for processing. This double pulse femtosecond laser process can be processed at lower laser intensity and processed with less damage. Pulse interval of 400 fs showed lowest processing threshold and after 10 ps, processing threshold was gradually increased.*

Silicon carbide (SiC) is known as a very useful semiconductor for high power, high breakdown voltage and high temperature devices. Because of such characteristics, it is difficult to process SiC by machining, chemical machining, laser machining and so on. Femtosecond laser to cause multi photon absorption, however, can be processed SiC.

We propose a new SiC processing method, double pulse femtosecond laser process. When the laser is irradiated to the semiconductor, electrons in the valence band are excited to the conduction band by absorbing photon energy ($E = h\nu$). This excitation is continued for about 10 pico second and electrons in the conduction band behave like free electrons , resulting in light absorption rate of the semiconductor increases. Thereby, we expect that semiconductor of the excited state can be processed at lower laser intensity and processed with less damage. In this report, by measuring the machining threshold while changing pulse interval of the double pulse, consider the validity of the proposed method.

Experimental apparatus was created based on Michelson interferometer with a Ti:Sapphire laser with the duration of 64 fs at a wavelength of 794 nm and pulse interval can be set up 0 s to 400 ps by electric stage. The sample was 4H-SiC(0001) polished surface, and the polarization direction of the laser was set at (11-20) surface. Each pulse fluence (peak fluence) was nearly 800 mJ/cm^2 which is less than machining threshold by single pulse process. In the experiment, We set the pulse interval of 400 fs, 1 ps, 4 ps, 10 ps, 40 ps, 100 ps and 400 ps, and conducted once irradiation with double pulse. After that, the processing marks were observed with a Scanning Electron Microscope(SEM) to derive the processed threshold.

Experimental results , processing threshold in a double pulse processing was reduced up to 48 % compared to that of a single pulse. Pulse interval of 400 fs showed lowest processing threshold, and after 10 ps, processing threshold was gradually increased. In the presentation, we will show the details of the experiment data, and the processing mechanism.