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フォノン援用光解離による二酸化炭素の削減
Carbon Dioxide reduction process using phonon assisted photo-dissociation

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Carbon dioxide (CO_2) is considered as one of the major greenhouse gases responsible for global warming. The use of solar energy is most likely to be an economic solution for reducing CO_2. However, high bond dissociation energy of CO_2 (equivalent light wavelength λ_{dis}= 147nm) makes it challenging to dissociate CO_2 efficiently [1]. The purpose of this research is to investigate photo-dissociation process of CO_2 with incident light energy less than its bond dissociation energy. The process is called as phonon assisted photo-dissociation [2].

When propagating light is incident on a particle with a size smaller than the wavelength of the light, a virtual cloud of photons (dressed photon) gets localized around the particle, which induces the excitation of phonons. Therefore, a molecule around that particle can absorb multimode coherent phonons and electrons of the molecule get excited from the ground state to an excited state via an intermediate state. This two or more step excitation is the basis of phonon-assisted photo-dissociation.

To induce phonon assisted process, we fabricated ZnO nanorods on sapphire substrate using a catalyst free MOVPE system [3]. The average tip diameter of the fabricated nanorods (Fig. 1) was approximately 50 nm. We put the substrate with ZnO nanorods inside a desiccator filled up with CO_2 gas and irradiated the nanorods with UV light source. Concentration change of CO_2 is understood by observing the change in absorption spectrum of CO_2 measured by Infrared spectrometer. Figure 2 shows the absorption change at wavelengths corresponding to the CO_2 molecules [4] with irradiation time using deuterium lamp and UV laser of wavelength λ =213 nm (> λ_{dis}).We found that the absorption changes significantly while irradiating with incident light of wavelength longer than λ_{dis}. The result of our experiment supports the process of phonon-assisted photo-dissociation. We are planning to conduct the experiment several times, changing the parameters- incident light wavelength, power and nanorod structure to find out the optimum condition for dissociation of CO_2.

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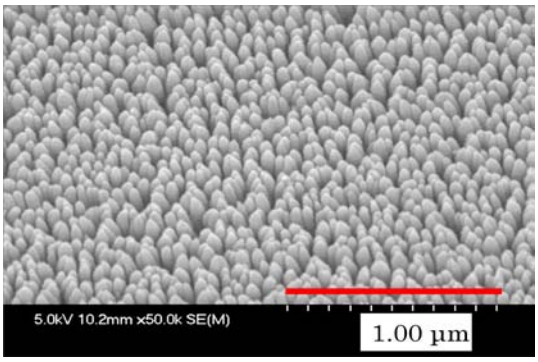

Fig. 1 SEM image of ZnO nanorods

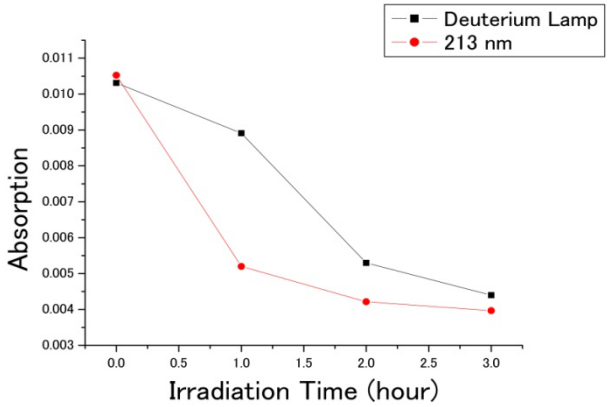

Fig. 2 Absorption change with irradiation time