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E フューエル候補である炭酸ジメチルの液滴蒸発および点火実験

Experiments on droplet evaporation and ignition of dimethyl carbonate as an e-fuel candidate

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Droplet evaporation and ignition of dimethyl carbonate (DMC), which is one of promising carbon neutral fuels, has been studied experimentally in order to obtain reference data for numerical simulation of spray combustion. Experiments will be performed at microgravity because natural convection can be suppressed and spherically symmetric phenomena can be observed. Experimental data of spherically symmetric droplet evaporation and ignition are convenient for validation of numerical simulation results. In this report, the experimental apparatus adjusted to DMC droplet experiments and its ground test results are explained.

Figure 1 shows a schematic diagram of the experimental apparatus, which has been used for hydrocarbon fuels[1)]. Rubber of sealing materials exudes into DMC and remains at the droplet suspension system after droplet evaporation as shown in Fig. 2. Therefore, sealing materials which contain rubber are removed from the fuel supply system. For droplet ignition experiments, droplet suspension fibers of the droplet suspension system are changed from an alumina silica fiber to a silicon carbide fiber (diameter: 0.014 mm) to improve fire resistance. A fuel droplet are generated at the intersection of the silicon carbide fibers using a micro syringe

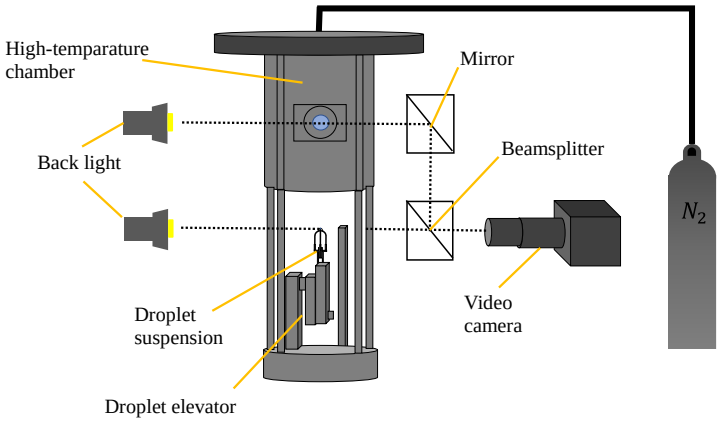


Fig. 1 Experimental apparatus.

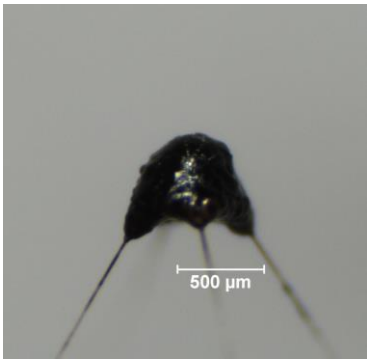
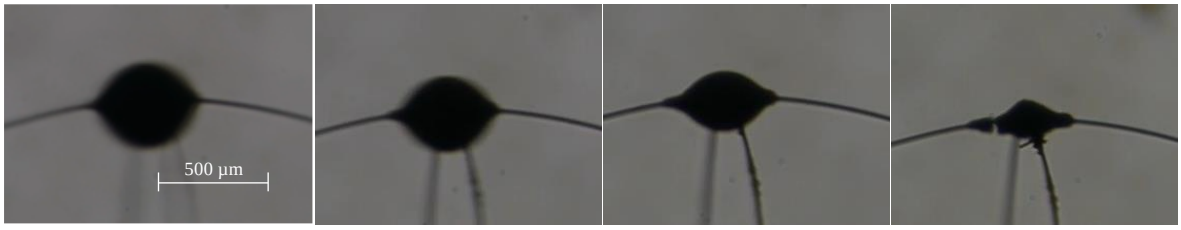


Fig. 2 Residual.



t = 0.12 s t = 0.28 s t = 0.45 s t = 0.62 s

Fig. 3 Evaporation process of a DMC droplet at 673 K in ambient temperature.

made from glass and stainless steel. Backlit image of a suspended droplet at the droplet generation section is recorded with a video camera and a lower back light to measure initial droplet diameter. When droplet diameter becomes target diameter, the suspended droplet is introduced into the high-temperature chamber by the droplet elevator and backlit image of the droplet was recorded with the video camera and a upper back light to measure temporal variation of the droplet diameter. In the case of droplet evaporation experiments, the high-temperature chamber is filled with nitrogen to avoid ignition.

Droplet evaporation experiments are conducted at atmospheric pressure and under normal gravity condition. Ambient temperature was varied from 473 to 773 K. Figure 3 shows the sequential backlit images of a DMC droplet evaporating at ambient temperature of 673 K. The DMC droplet with the initial droplet diameter of 0.49 mm took 0. 57 s to evaporate completely. When ambient gas was changed to air at 773 K in ambient temperature, a DMC droplet ignited and the droplet suspension fibers were not broken. Figure 4 shows the history of droplet diameters at various temperatures when droplet are deposited on SiC fibers. At any temperature, $(d/d_0)^2$ decreases approximately linearly in keeping with d^2 law. The slope of the line increased with higher ambient temperatures. The results of these experiment can be used for decision of experimental conditions for microgravity experiments and evaluation of the effect of natural convection.

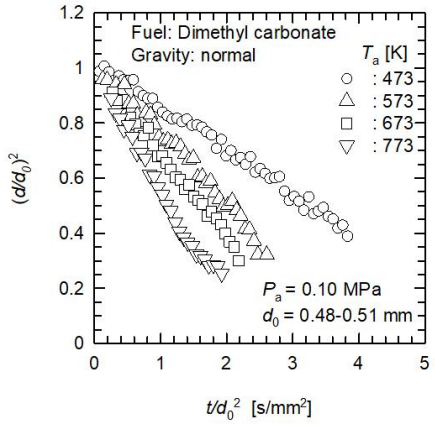


Fig. 4 Droplet diameter histories of DMC (SiC fiber).

References

H. Nomura, T. Murakoshi, Y. Suganuma, Y. Ujiie, N. Hashimoto, H. Nishida : Microgravity Experiments of Fuel Droplet Evaporation in Sub- and Supercritical Environments, Proc. Combust. Inst. 36(2017), 2425-2432.