

# HU-ACE NEWS LETTER

Advanced Core for Energetics, Hiroshima University

Vol. 30  
2019.6

## Activities of the Core

- |              |  |
|--------------|--|
| Jun 4, 2019  | The 112 <sup>th</sup> Hiroshima University Mechanical System Seminar (co-organization) |
| Jun 13, 2019 | The 75 <sup>th</sup> Hiroshima University Biomass Evening Seminar (co-organization)    |
| Jun 25, 2019 | The 34 <sup>th</sup> HU-ACE Steering Committee Meeting                                 |

### Biomass Evening Seminar goes on

The Hiroshima University Biomass Evening Seminar, which introduces topics related to biomass once a month, is hosted by the Biomass Project Research Center and HOSTY Association. HU-ACE is also co-organizing it. The seminar on June 13th was the 75th seminar. This time, it was a research presentation about the oil which takes an important position in the field of biomass. Research on treating the oil in the drainage with algae, research on producing high value added oil using microorganisms, and research on hydrothermal treatment of palm oil mill effluent were presented.



Issued by Advanced Core for Energetics, Hiroshima University

HU-ACE Secretariat, Research Planning Office, Hiroshima University,  
1-3-2 Kagamiyama, Higashi-Hiroshima, 739-8511 Japan  
<http://home.hiroshima-u.ac.jp/hu-ace/en/>

# Research Topics



## Fundamental Researches on Laser Ignition

**Takuma Endo**

Professor, Graduate School of Engineering, Hiroshima University

Research field: Engineering/Integrated engineering/Aerospace engineering

Keyword: Thermal spraying/Engine/Laser/Detonation

### Abstract

#### Background

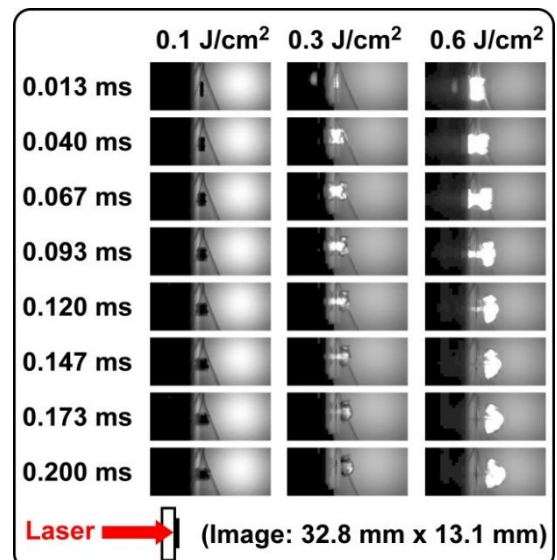
The development of spark-ignition engines proceeds toward lean-burn high-compression-ratio engines offering greater fuel economy but requiring durable high-energy ignition devices. Higher spark energy tends to decrease the life of the conventional spark plug. Recent advances in laser technology have made laser devices smaller and cheaper, and laser ignition a promising next-generation ignition technology. Note that laser can easily induce higher-energy ignition at higher pressures, and high flexibility in the timing and placement of ignition is often emphasized as the principal advantage of laser ignition facilitating the combustion of lean-fuel mixtures.

#### Our Researches on Laser Ignition

With a Nd:YAG laser of 10-ns pulse duration, we have experienced (A) experiments on laser-induced gaseous breakdown and improvement of laser-absorption efficiency [1], (B) experiments comparing laser ignition and conventional spark-plug ignition with premixed combustible gas mixtures [2,3], and (C) experiments on the cleaning effect of the laser-entrance optical window by the igniting laser itself [4]. Almost all experiments were carried out as single-shot experiments, and our researches on laser ignition are rather fundamental.

#### Recent Work

The right figure shows some experimental results on the laser cleaning [4]. A transparent glass plate was artificially sooted using candles, the soot was irradiated by 10-ns 1064-nm Nd:YAG laser of 5-mm diameter through the glass plate, and we observed the soot-removal process. The soot blown off by the laser irradiation is clearly recognized. The aerodynamic force produced by the flow induced by the laser-heating of the soot is the most plausible soot-removal mechanism. In addition, the degree of clearness of the glass plate can be kept more than 98% when the laser-pulse fluence is more than 0.6 J/cm<sup>2</sup>.



#### References

- [1] T. Endo, Y. Takenaka, Y. Sako, T. Honda, T. Johzaki, and S. Namba, "Reinjection of transmitted laser light into laser-produced plasma for efficient laser ignition," *Appl. Opt.*, Vol. 55, pp. 1132-1137 (2016).
- [2] T. Endo, Y. Takenaka, Y. Sako, T. Johzaki, S. Namba, and D. Shimokuri, "An experimental study on the ignition ability of a laser-induced gaseous breakdown," *Combust. Flame*, Vol. 178, pp. 1-6 (2017).
- [3] T. Endo, K. Kuwamoto, W. Kim, T. Johzaki, D. Shimokuri, and S. Namba, "Comparative study of laser ignition and spark-plug ignition in high-speed flows," *Combust. Flame*, Vol. 191, pp. 408-416 (2018).
- [4] T. Endo, K. Okada, Y. Ito, W. Kim, T. Johzaki, and S. Namba, "Experiments on laser cleaning of sooted optical windows," *Appl. Opt.*, Vol. 57, pp. 10522-10527 (2018).