Advanced Core for Energetics, Hiroshima University Vol. 64

HU-ACE NEWS LETTER

Advanced Core for Energetics, Hiroshima University

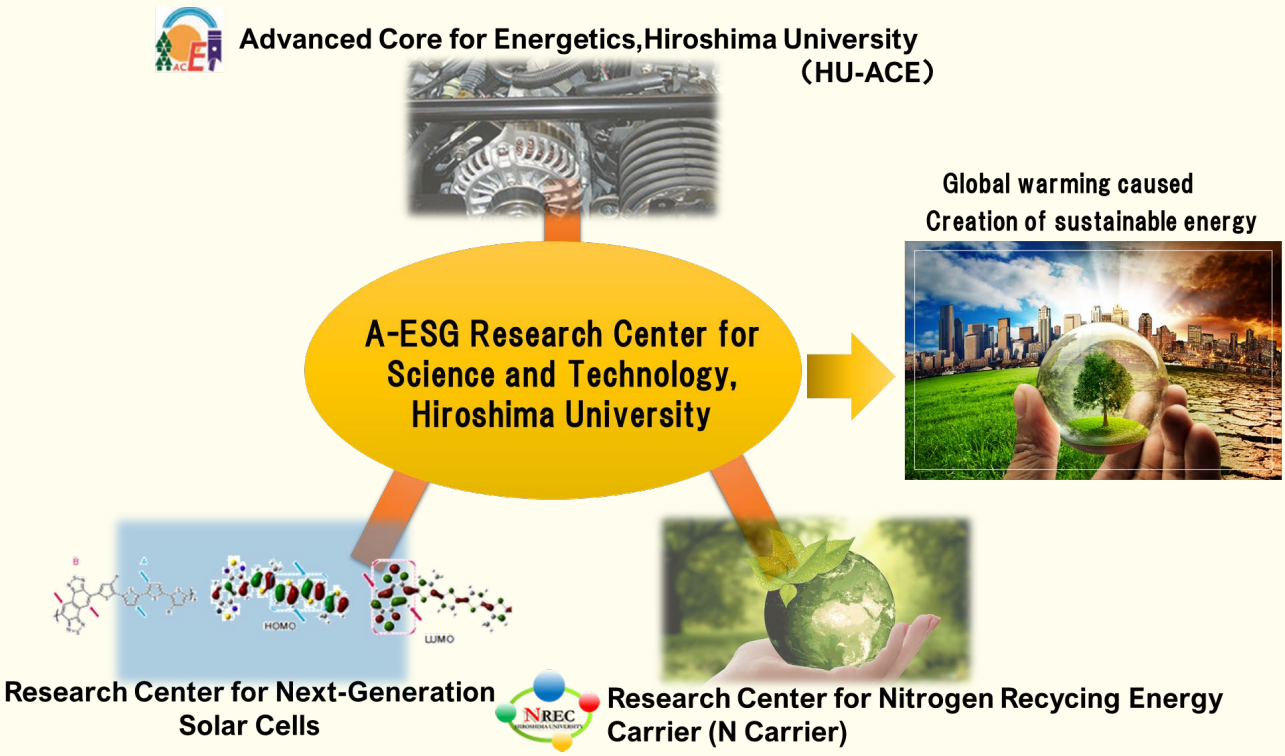
Vol.64
2022.4

Activities of the Core

Apr. 6, 2022 The 70th HU-ACE Steering Committee Meeting.

A-ESG Science and Technology Research Center, Hiroshima University, has been founded.

On Apr. 1, 2022, Hiroshima University founded a new university common educational and research facility, the Academic-Environment Social Governance Science and Technology Research Center, for the purpose of advancing research and human resource development with the aim of reducing global warming caused by greenhouse gas emissions, and creating sustainable energy to contribute to the solution of global problems related to the environment and energy. Three research cores, Advance Core of Energetics, Center for Next Generation Photovoltaics, and Research Center for Nitrogen Recycling Energy Carrier are especially in intimate relation, and will collaborate with the new center. It is expected that the scope of activities within HU-ACE will be increased.



Issued by Advanced Core for Energetics, Hiroshima University
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Research Topics

Elucidation of flame propagation mechanism of metal powders in a microgravity environment

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Research field: Engineering/Integrated engineering/Energy engineering, Safety engineering
Keyword: Combustion/Explosion/Dust combustion/Safety

Abstract

We introduce herein a microgravity project led by HU on dust explosions. The risk of dust explosions continuously exists in a lunar and planetary exploration activities, since the settling influence of dispersed combustible particles is reduced in microgravity conditions. However, the prevention and mitigation of dust explosions in the space environment have not yet been considered. Studies on the risk of dust explosion are required because accidental dust explosions may occur in microgravity environments such as lunar and planetary exploration. It is necessary to manage the dust concentration below the minimum explosible concentration in a microgravity environment for lunar and planetary exploration, and planet residence. In order to overcome these issues and to establish fire safety protocols for dust explosions, it is indispensable to investigate the minimum explosible concentration at the extremely low speed flow field. Our research aims to find a solution for this challenging problem of minimum explosible concentration (MEC) of dust clouds to overcome these issues and to establish safety protocols for dust explosions. Metal powder can be used as fuels in solid rocket propellants for the exploration of Space such as the Moon or Mars. This project also aims to develop an energy circulation system that utilizes metal powder as fuel in Space as shown in Fig. 1.

The front-loading research funded by Japan Aerospace Exploration Agency (JAXA), Institute of Space and Astronautical Science (ISAS) investigated the dependence of flame propagation mechanism on aluminum dust concentration near the minimum explosible concentration of dust explosions. The flame behaviors of aluminum-air mixtures in microgravity was investigated at the 2.5 second drop tower, known as COSMOTORRE of Uematsu Electric Co., Ltd. with gravity levels at about 10^{-3} G, and parabolic flight with 20 seconds of microgravity time and gravity levels at about 10^{-2} G. However, the microgravity tests for measuring accurate MEC of dust clouds are only possible in long-duration microgravity experiments. We are developing an experimental apparatus in collaboration with European research teams for the observational experiments of MAXUS-9 and TEXUS-56 rockets.

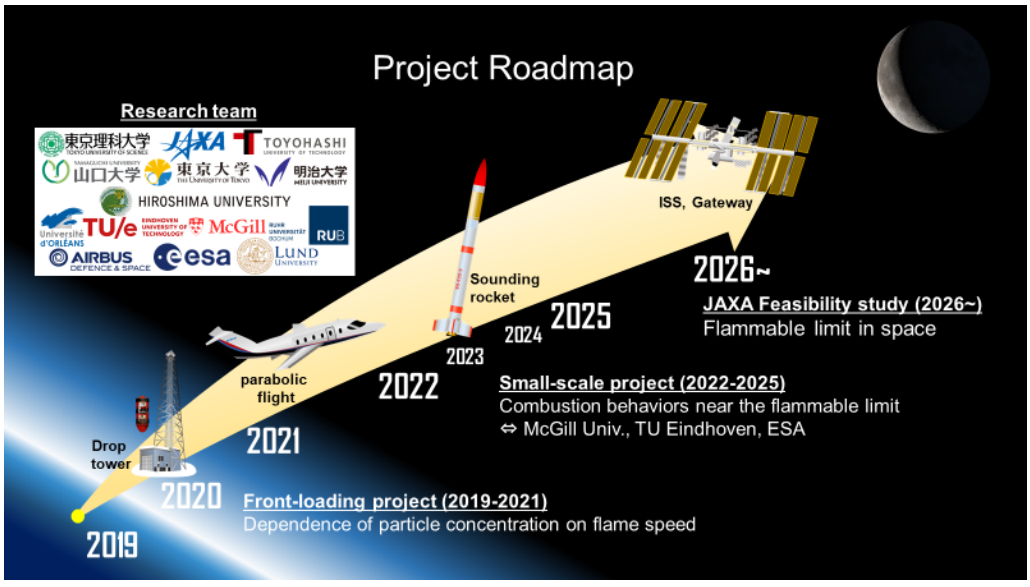

Figure 1. Timeline and objectives of dust explosions project.