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FLARE プロジェクト -新たな宇宙火災安全基準構築を目指して-

FLARE Project -building up new standard for fire safety in space-

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1. Brief description of the project

Fire safety is one of the most important issues in manned space mission. In the protocol to ensure fire safety in the spacecraft, material screening method takes an important role to prevent ignition and subsequent flame spreading. Up to now NASA-STD-6001B (or ISO14624-1), which is a test in normal gravity, have been used to evaluate the material flammability and to screen materials for use in spacecraft. However, recent studies show material flammability could be higher than that in normal gravity [1,2], which means the test on the ground does not guarantee conservative judgement. Therefore, building up new method to quantify material flammability difference in normal gravity and microgravity is very important. The main target of the FLARE project is to develop such method for flat sheet material and electric wire. The developed method will be provided to space agencies (ex.NASA, ESA, JAXA and others) as a technical information to help better judgement of material screening for use in spacecraft from a view of fire safety.

2. Research team

The FLARE project is promoted as a JAXA high-priority-project utilizing ISS started in 2012 and its research team includes many universities and agencies, Hokkaido University (PI), Hirosaki University, The University of Tokyo, Shinshu University, Toyohashi University of Technology, Gifu University, University of California at Berkeley, Sorbonne University, University of Bremen, NASA, ESA, CNES, DLR, and JAXA. The research team hold international workshop every year and the latest one was held online through Sep.16-18 as the 7th workshop.

3. Progress status

The material flammability is given by limiting oxygen concentration (LOC) below which spreading flame is not sustained. Once the minimum value of LOC in microgravity (MLOC) is found the value of MLOC could be compared with oxygen concentration in the space craft. The theory behind the presence of MLOC is the two mechanisms of flame extinction, blow-off extinction and quenching-extinction. In middle of the regimes dominated by two different mechanisms the most flammable condition resulting in MLOC appears. The procedure to find MLOC of spreading flame in opposed air flow, which is uniquely called as OI-mg, for flat sample is available in Ref.[3] by Takahashi, et al. Then, estimated OI-mg by the developed method will be compared with actual OI-mg obtained by ISS experiments as well as the limiting oxygen concentration

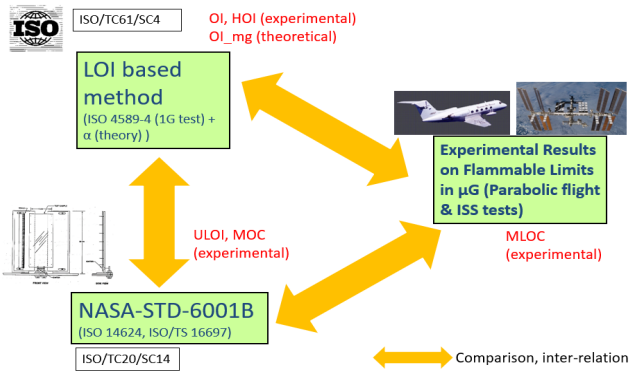

Fig.1 Verification of new material flammability test method

given by conventional NASA test method, ie. ISO14624-1. The concept of the comparison is shown in Fig.1 and validity of the new method will be confirmed. Another effort to build up estimation method of OI-mg for electric wire or rod shape sample are also made in parallel with flat sheet sample [4].

The hardware for the solid material flammability test in ISS is called as SCEM (Solid Combustion Experimental Module) [5] and was successfully launched by HTV-9 to the ISS on May 21, 2020 [6]. The first experiments on orbit by SCEM is expected near the end of 2020.

4. Summary and future

The brief description and progress status of FLARE project are given in the manuscript. Through the FLARE project a new method to quantify the extension of flammability limit in terms of oxygen concentration will be provided. The new method will provide an option to screen material intended to use in spacecraft from the view of fire safety.

The Artemis program under initiative of NASA may include different types of manned activities, transit to the Moon, activities on orbit of gateway, landing on the Moon, activities on the Moon surface, and beyond the Moon. Depending on the activity, oxygen concentration and pressure inside the spacecraft or human habitat could be different. Then fire safety risk would change depending on the atmosphere design in the spacecraft or human habitat. The FLARE project team expect the outcome of the project can provide essential contributions to maintain the fire safety in any manned space missions in the Artemis program.

Acknowledgement

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