

**PJLA
Testing**

Certification No. 115836

E22-043 Rev. 1.0

October 20, 2022



飯田工業技術試験研究所環境試験部門 Iida Industrial Technology Test & Research Laboratory

10th Triennial International Aircraft Fire and Cabin Safety
Research Conference :

Experimental Study of Flammability Test on Our Test Facility.

Iida Technical Technology Test & Research Laboratory
Hisashi Kinoshita, Tomohiro Yanase, Norio Takahashi, Tadahiro Wakui
Collaborated with Masato Nakazawa, Tsuyoshi Muraoka,
Tokyo Metropolitan Industrial Technology Research Institute

October 20, 2022

Agenda

1. Introduction of S-BIRD
2. Environmental Test Facilities in S-BIRD
3. Impact Study of Flammability Test
4. Flammability Test Materials and Method
5. Flammability Test Setup Parameters
6. Clipping Directional Dependency of Plastic Materials
7. Altitude and Test Equipment Effect of Flammability Test
8. Conclusion

1 .Introduction of S-BIRD

- S-BIRD is a facility for achieving high added value under the collaboration between the Minami Shinshu Wide Area Union, Nagano Prefectural Industrial Technology Center, Shinshu University, Minami Shinshu/Iida Industrial Center.
- S-BIRD is named after the **S** of South Shinshu and Shinshu, and **BIRD**: it was named in the image of an aircraft that flies into the sky like a bird **flying in the sky**.
- **BIRD**'s **B** means **Breakthrough**, **I** means **Innovation**, and **RD** means **Research & Development**.



2.Environmental Test Facilities in S-BIRD(1/2)

- With the support of the Ministry of Economy, Trade and Industry (METI) and the Kanto Bureau of Economy, Trade and Industry, the following environmental test facilities have been introduced in the Iida Industrial Technology Testing Laboratory (S-BIRD) from JFY2015 to JFY2020.
 1. Temperature/Altitude/Humidity/Icing Test Facility.
 2. Explosion-Proof Test Facility.
 3. Fire, Flammability, Smoke Density, Heat Release Rate Test Facilities.
 4. Temperature Variation Test Facility.
 5. Vibration and Shock Test Facility.

We are conducting the research study using Fire & Flammability Test equipment, and we would like to provide our results in this conference.

2. Environmental Test Facilities in S-BIRD(2/2)



**Temperature/Altitude/Humidity/
Icing Test Facility**



Explosion-Proof Test Facility



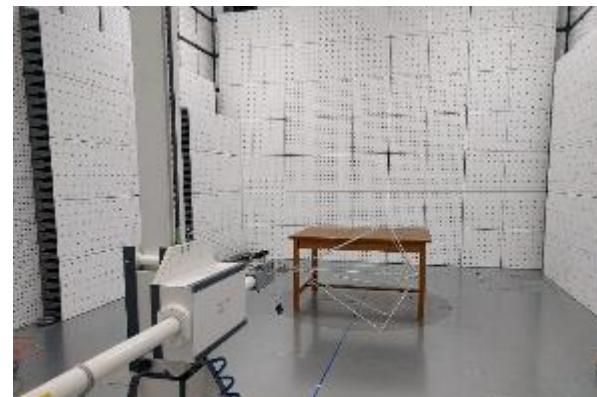
Fire, Flammability Test Facility etc.



Temperature Variation Test Facility



Vibration and Shock Test Facility.



EMC Test Facility (3meter Shied Room)

3.Impact Study of Flammability Test

We investigated the Horizontal Flammability test in view points of the following issues;

1. **Flammability Test set up parameters.**

We study the effect on the test condition with or without 24hours minimum conditioning on test results as the most influential parameter of the Flammability test.

2. **Clipping directional dependency of Plastic Materials.**

We study the effects of burning phenomenon (anisotropic burning phenomenon) due to the difference of clipping direction of plastic materials.

3. **Altitude in the test laboratory location (S-BIRD location :500m) and Test Equipment Effect.**

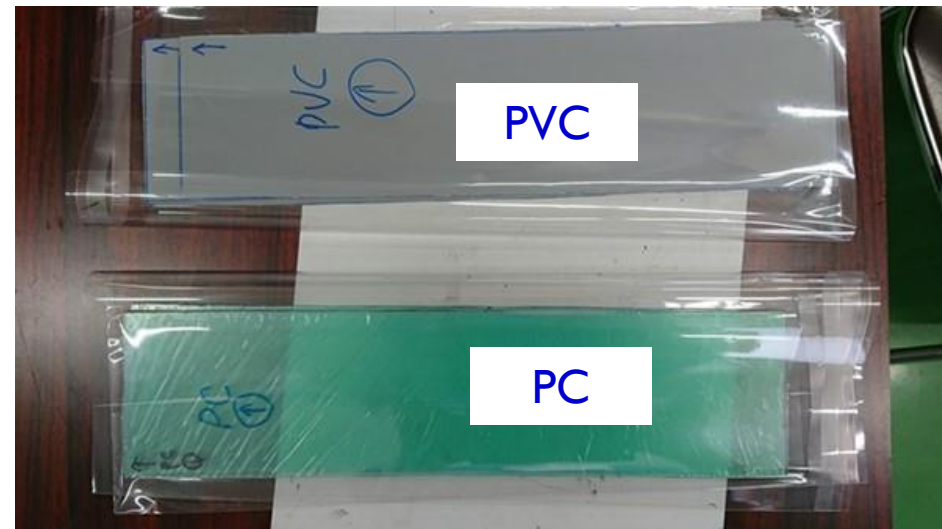
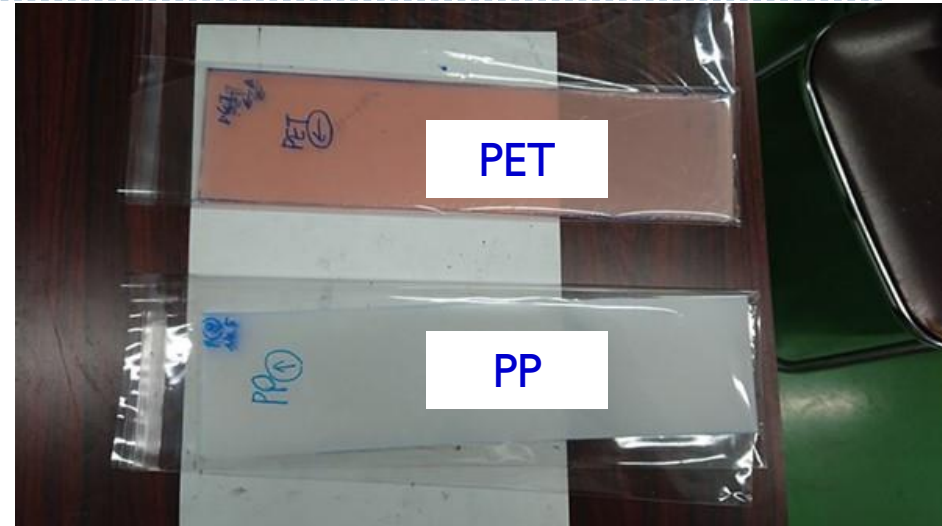
Our test laboratory is located at the sea level 500 m. We directly compare the test results with the test results at the sea level. In addition, we study the test results due to the difference of the flammability test equipment.

4. Flammability Test Materials and Method

We selected the following 4 Commercial-grade, General-purpose engineering plastic materials for our study:

1. Polypropylene (PP),
2. Polyvinyl chloride(PVC),
3. Polyethylene terephthalate (PET),
4. Polycarbonate (PC),

FAA Fire Handbook Chapters 2, Horizontal Bunsen Burner Test was applied as the evaluation method.



4.Flammability Test Materials and Method

- The following flammability test equipment was used.
 - Marlin Engineering Inc.
 - ME1000 Flammability Chamber



5.Flammability Test Setup Parameters(1/3)

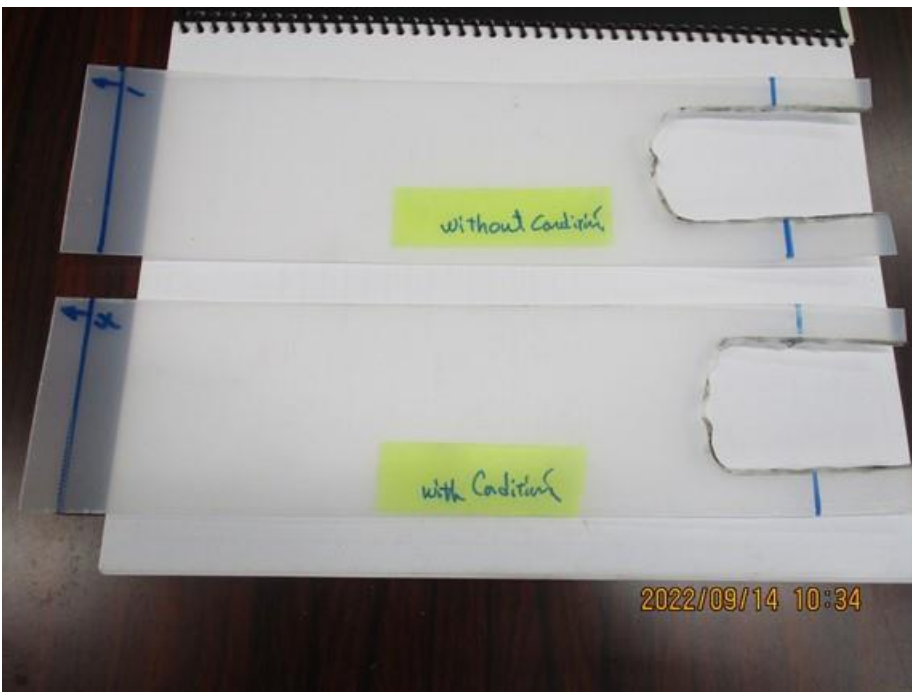
- The test results on burn length and burn rate data for with or without 24 hours minimum conditioning is shown in Table 1.

Table-1: Flammability test results with and without thermal conditioning

Material	24 hours Minimum Conditioning	Burn Length (mm) (average)	Burn Rate (mm/Min.) (average)
PP Parallel Clip	With	88.3	12.70
	Without	83.2	11.32
PP Perpendicular Clip	With	180.8	51.7
	Without	178.4	52.9
PVC	With	6.8	0 (self-extinguished)
	Without	6.5	0 (self-extinguished)
PET	With	8.8	0 (self-extinguished)
	Without	9.3	0 (self-extinguished)
PC	With	56.5	15.90
	Without	50.5	11.70

5. Flammability Test Setup Parameters(2/3)

- As shown in the test results, we found no major difference of the burn length and burn rate with or without 24hours minimum conditionings.
- This result means that the rates of water or moisture absorption are very low for the tested plastic materials.

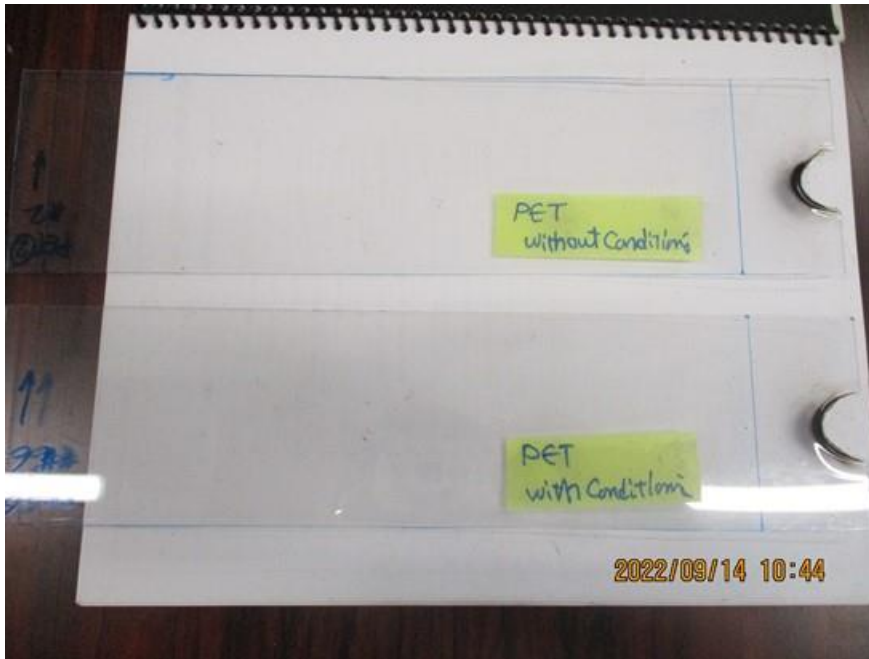


PP Material

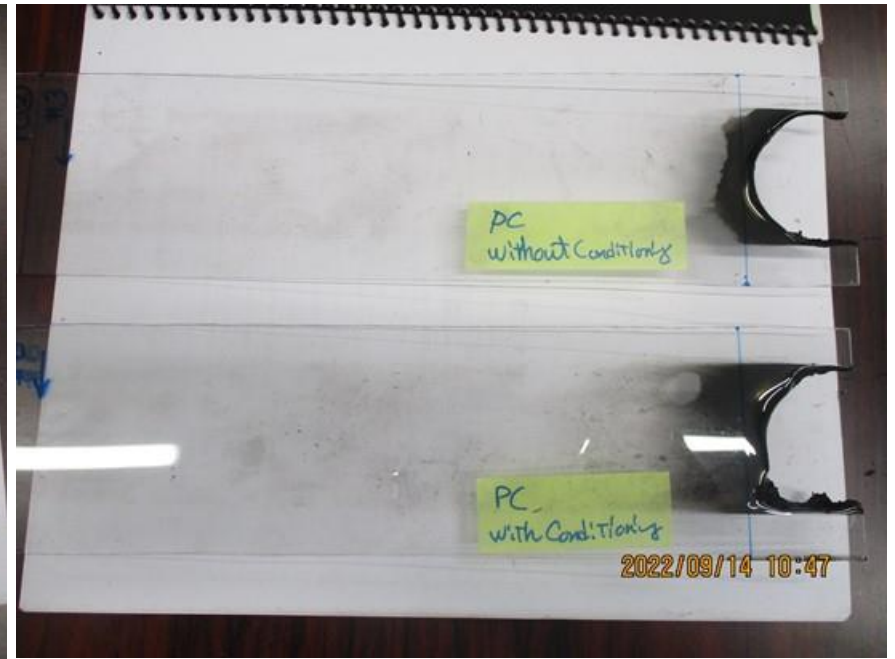


PVC Material

5.Flammability Test Setup Parameters(3/3)



PET Material



PC Material

6.Clipping Directional Dependency of Plastic Materials(1/3)

- The test results on burn length and burn rate data against the clipping directional (**Note***) dependency of materials is shown in Table 2.

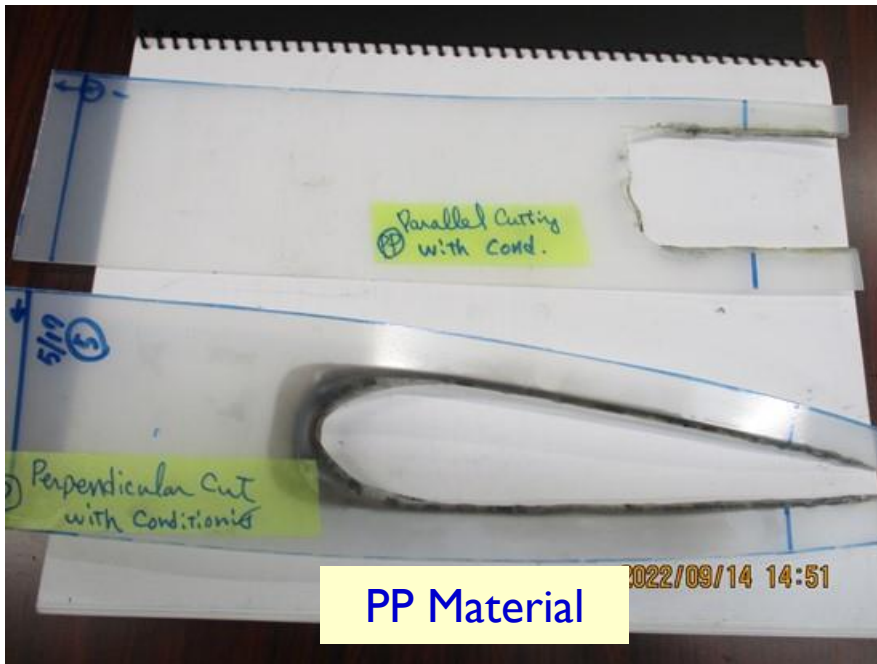
Note*: We could not determine the stretched direction and so we defined the clipping direction as receiving condition of the sheet material.

Table 2: Flammability test results with different clipping directions

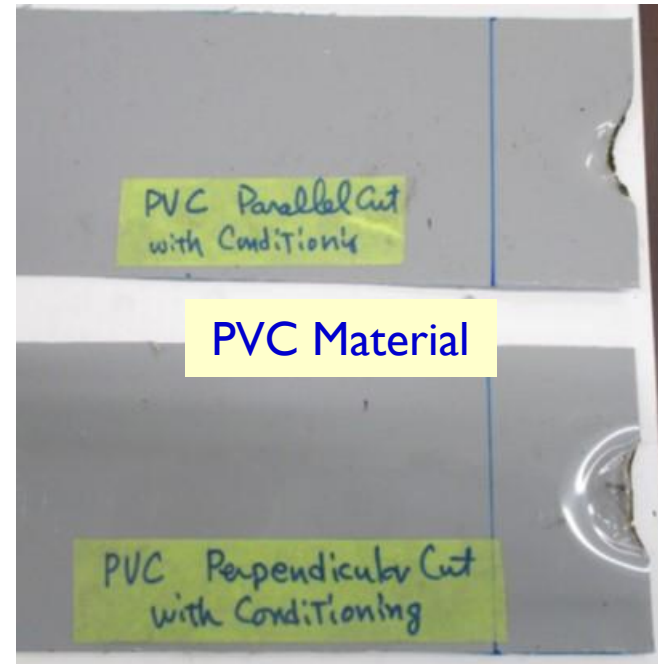
Material	Clipping Direction	Burn Length (mm) (average)	Burn Rate (mm/min.)(average)
PP	Parallel	88.3	12.7
	Perpendicular	180.8	51.7
PVC	Parallel	6.8	0 (self-extinguished)
	Perpendicular	3.8	0 (self-extinguished)
PET	Parallel	8.8	0 (self-extinguished)
	Perpendicular	11.7	0 (self-extinguished)
PC	Parallel	56.5	15.90
	Perpendicular	49.4	7.78

6. Clipping Directional Dependency of Plastic Materials(2/3)

- We found the following test results;
 1. The different burning behavior for PP material.
 2. The very slightly different burn behavior for PVC, PC and PET. These differences have no major impact of the flammability test results.
 3. The difference of burn rate for PP is depending on the clipping direction, and this seems to be caused by the difference in polymer size due to stretching direction when sheet manufacturing.



PP Material



PVC Material

6.Clipping Directional Dependency of Plastic Materials(3/3)



PET Material



PC Material

7. Altitude and Test Equipment Effect of Flammability Test(1/5)

- Our Test facility is located 500 m (1640 ft) above sea level.
- In order to confirm the altitude effect of flammability test results, we conducted the comparison test at the Tokyo Metropolitan Industrial Technology Research Institute (TIRI), which is located at almost sea level.
- Typical Ambient Condition
 - S-BIRD : 22°C 60% **961hPa** (average)
 - TIRI: 24°C 61% **1014hPa**
- In addition, we found the structural difference of the Flammability Test Equipment;
 - S-BIRD Equipment: Marlin Engineering ME1000 (Refer to Slide 9)
 - TIRI Equipment: Thermtech Industries LLC Model MPE-FAA



Model MPE-FAA

Extracted from
http://thermtechindustries.com/thermtech_flammability_test_cabinets_013.htm

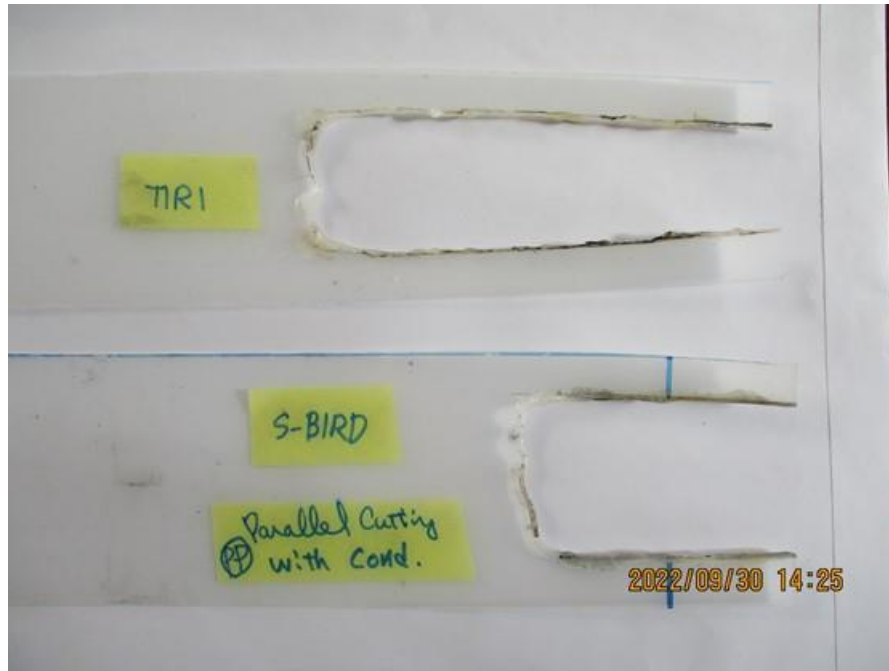
7. Altitude and Test Equipment Effect of Flammability Test(2/5)

- All test coupons were conducted by 24 hours minimum conditioning before test per Test procedure.
- Test results are shown in below; **Upper S-BIRD, Lower: TIRI**

Material (Clipping Dir.)	Burn Length (mm) (average)	Burn Rate (mm/Min.) (average)	Remark
PP Parallel	88.3	12.70	
	158.0	29.8	
PP Perpendicular	180.3	51.7	
	263	56.3	
PVC Parallel	6.8	0 (self-extinguished)	
	11.0	0 (self-extinguished)	
PET Parallel	8.8	0 (self-extinguished)	
	11.0	0 (self-extinguished)	
PC Parallel	56.5	15.9	
	114	27.0	

7. Altitude and Test Equipment Effect of Flammability Test(3/5)

- Test results of both PP Material (parallel clip) and (perpendicular clip) show the similar but slightly flammable behavior against the TIRI test.
- Regarding the burn rate, PP material (parallel clip) has about two time difference of burn rate compared with S-BIRD test.



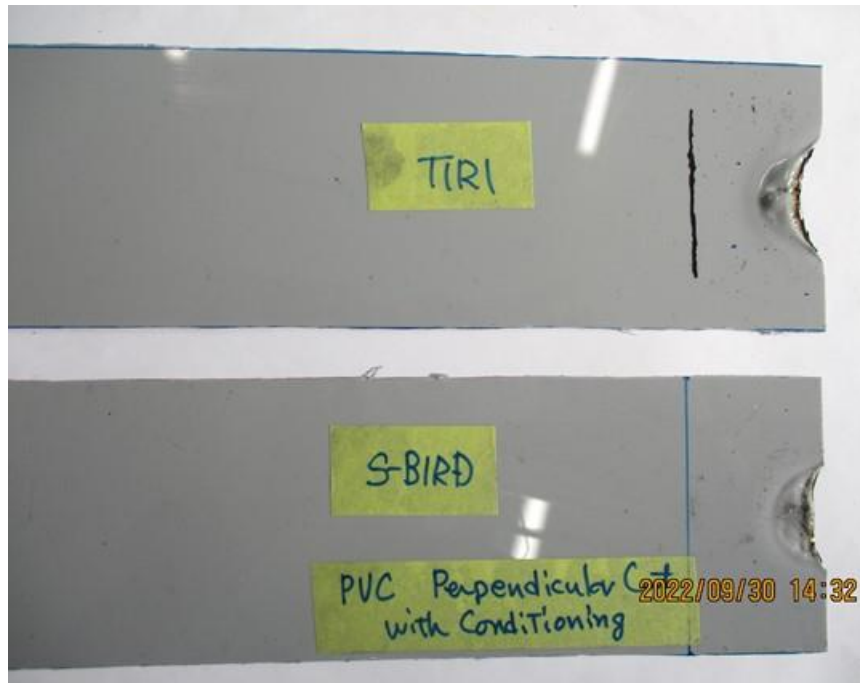
Test results of PP Material(parallel clip)



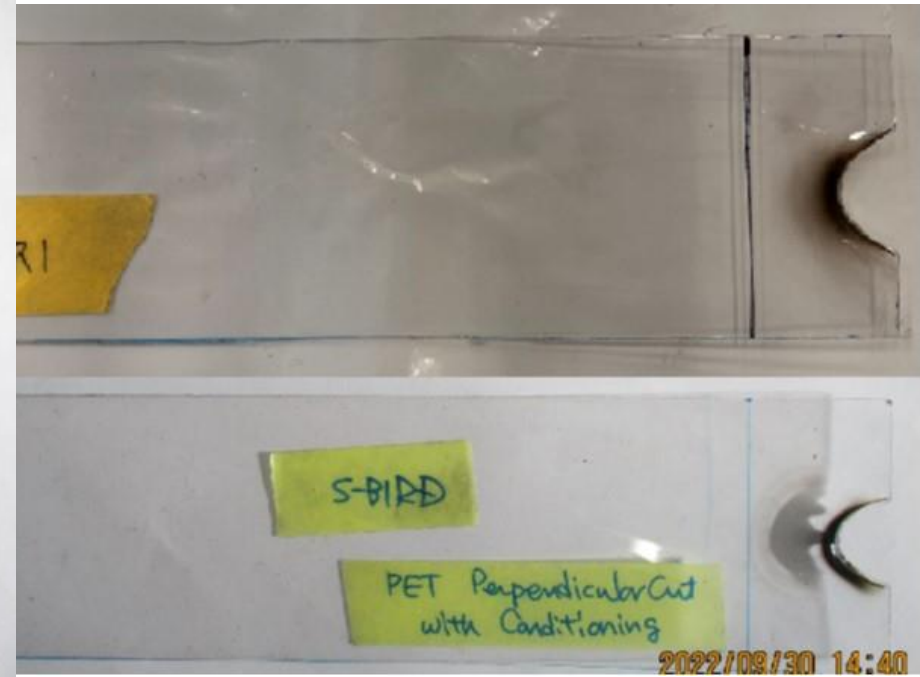
Test results of PP Material(perpendicular clip)

7. Altitude and Test Equipment Effect of Flammability Test(4/5)

- Test results of both PVC Material show the same flammable behavior.
- Test results of both PET Material show the same flammable behavior.



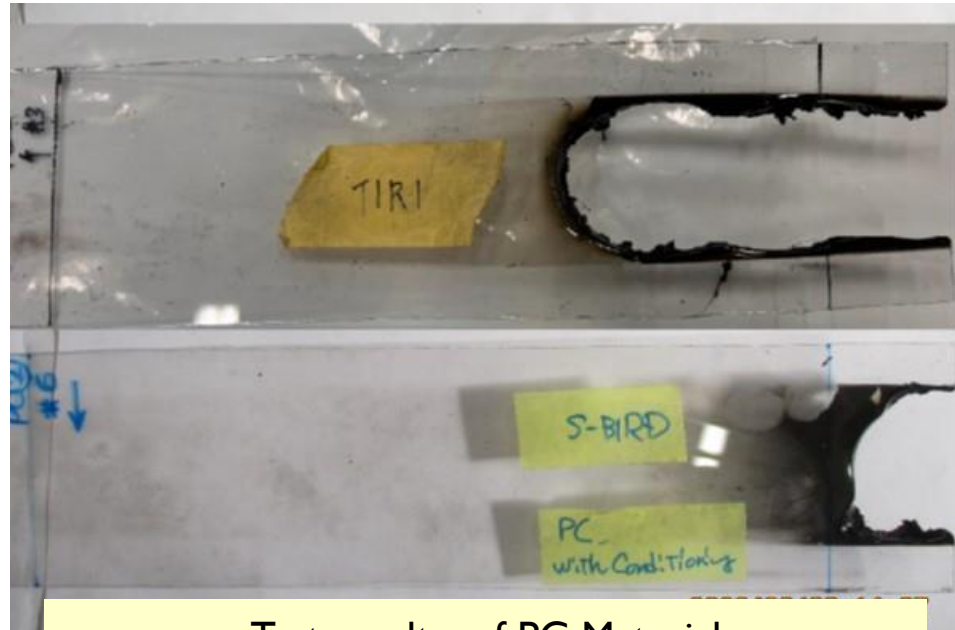
Test results of PVC Material



Test results of PET Material

7.Altitude and Test Equipment Effect of Flammability Test(5/5)

- Regarding the burn length and burn rate, PC material has about two time difference compared with S-BIRD test.



Test results of PC Material

- In order to study the effect on the location of Test facilities, we conducted the same Test between S-BIRD (altitude 1640 ft) and TIRI(at sea level) .
- The test results (burn length, and burn rate) shows the dependency of the plastic material. For the PP and PC materials, we found two times difference, and for PVC and PET, we have the same results.
- We did not identify the difference results for PP and PC material . It seems to be due to the Test Equipment effect rather than altitude difference.
- We will further study the Test Equipment effect as the root cause of this different behavior.

8.Conclusions

We investigated the Horizontal Flammability test in view points of the following issues;

1. **Flammability test set up parameters**

We studied the effect on the test condition with or without 24hrs minimum conditioning and found no major impact of the horizontal burning test results for the tested materials.

2. **Clipping directional dependency of Plastic Materials.**

We studied the effect on the clipping directional dependencies (anisotropic burning phenomena) of the plastic materials. Polypropylene shows the difference burning behaviors caused by the difference in polymer size due to stretching direction when sheet manufacturing

3. **Altitude in the test laboratory location (S-BIRD location :500m) and Test Equipment Effect.**

The test results (burn length, and burn rate) shows the dependency of the plastic material. For the PP and PC materials, we found two times difference, and for PVC and PET, the same results. We did not identify the difference results for PP and PC material. One of the reasons seems to be due to the Test Equipment effect rather than altitude difference.

4. **We will further study the Test Equipment effect as the root cause of the above different test results.**

****** End of Document ******

