P05

LPSO 型 Mg 合金プレートの超高速衝突における破壊特性

Fracture Properties of LPSO-Mg Plates in Hypervelocity Impact Experiments

○西田政弘, 児玉史哉, 石田魁人(名工大), 林浩一(鳥羽高専), 赤星保浩(九工大),
外本和幸, 眞山剛, 山崎倫昭, 河村能人(熊大)
○Masahiro Nishida, Kaito Ishida, Fumiya Kodama (NIT), Koichi Hayashi (NIT, Toba College),
Yasuhiro Akahoshi (KIT), Kazuyuki Hokamoto, Tsuyoshi Mayama, Michiaki Yamasaki,
Yoshihito Kawamura (Kumamoto Univ)

LPSO 型マグネシウム合金薄板にスペースデブリの衝突を模擬した超高速衝突実験を行った. クレータの形状やイジェクタの量を, アルミニウム材料などと比較し, マグネシウム材料の宇宙航空機構造材への利用を検討した.

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Masahiro NISHIDA[1], Fumiya KODAMA[1], Kaito ISHIDA[1], Koichi HAYASHI[2], Yasuhiro AKAHOSHI [3]
Kazuyuki HOKAMOTO[4], Tsuyoshi MAYAMA[4], Michiaki YAMAZAKI[4], and Yoshihito KAWAMURA[4]

1)名古屋工業大学 / Nagoya Institute of Technology
2)鳥羽商船高等専門学校 / National Institute of Technology, Toba College
3)九州工業大学 / Kyushu Institute of Technology
4)熊本大学 / Kumamoto University

1. Light Weight Magnesium Alloy/マグネシウムによる軽量化

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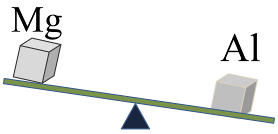
Launch Cost per Satellite :
80~110hundred million yen

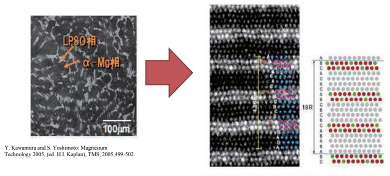


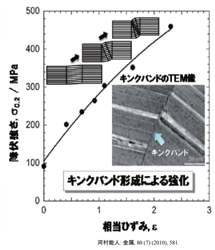
Lightest in practical metals

Weight reduction of sat→Reduction of launch cost

2. LPSO-Type Mg Dual Layer Alloy/LPSO型Mg二相合金

Strengthen by LPSO-layer, newly introduced magnesium material





Weak point of Mg alloy

- Low YS(160MPa)
- Highly reactive(581 ℃)
- Poor cold workability

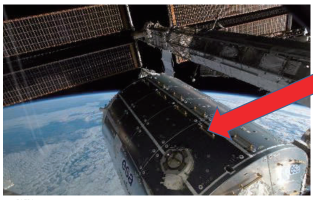
改善

LPSO-Mg

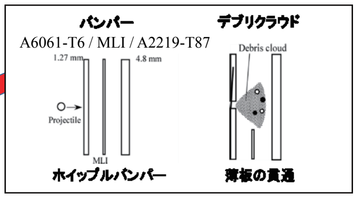
- YS equivalent to superduralumin (350 MPa)
- Thermal resistance (self ignition temp. 780〜940℃)

3. Reduction of Secondary Debris/二次デブリの抑制

Bumper shield of ISS



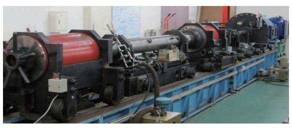
JAXA
欧州実験棟"COLUMBUS"
http://iss.jaxa.jp/library/photo/s122e008264.php



- Fist layer disperse the striking debris and lower the damage to the rear wall
- Fragments remain between the walls keep is from spreding

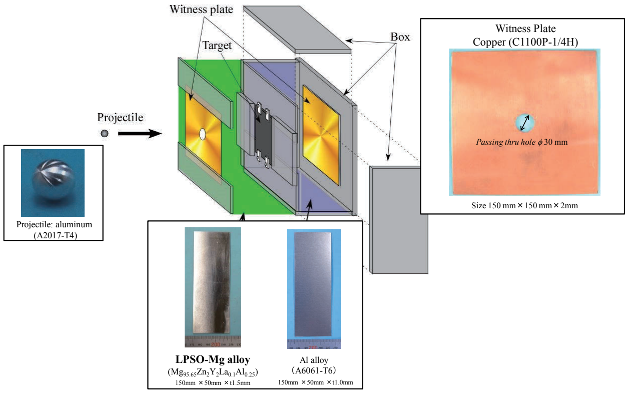
Consideration for usage of Mg alloy as first layer of the shield
Research of secondary debris is needed

4. Experiment Methods/実験方法

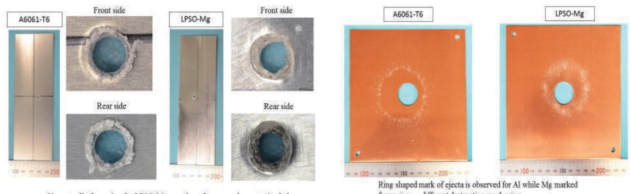


NIT Impact velocity 0.8 - 3.5 km/s

JAXA/ISAS Impact velocity 2.0 - 7.0 km/s



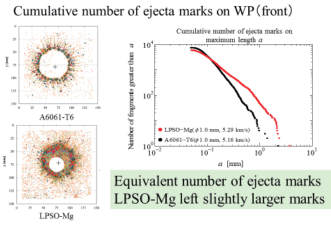
5. Experiment Result/実験結果



No crater lip formation for LPSO-Mg; rough surface around penetration hole

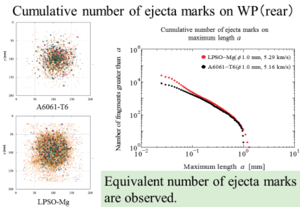
Ring shaped mark of ejecta is observed for Al while Mg marked fuzzy ring→different destruction mechanism

Cumulative number of ejecta marks on WP(front)



Equivalent number of ejecta marks
LPSO-Mg left slightly larger marks

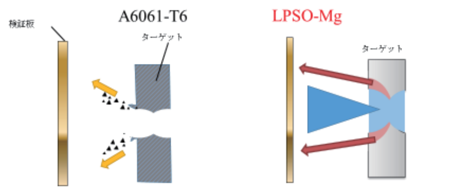
Cumulative number of ejecta marks on WP(rear)



Equivalent number of ejecta marks are observed.

6. Summary/まとめ

Study of Ejection Mechanism



Ejecting along crater base shape / Ejecting all frontward direction

Comparison between LPSO-Mg and A6061-T6 on penetration hole and ejecta size distribution

Penetration hole

- Rough surface around penetration hole for LPSO-Mg and slightly larger ejecta
  ⇔ Development of long crater lip and smooth surface around the hole

Ejecta

- LPSO-Mg ejected slightly large number of ejecta to front compared to Al
- LSPO-Mg ejecta is minimized to powder size