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3D-Printed Polymer-Based Conformal Space Radiation Shield with Heat Dissipation

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INTRODUCTION

Current Bulk Al shielding has high Size, Weight, and Power (SWaP) requirements

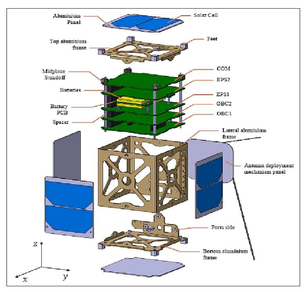
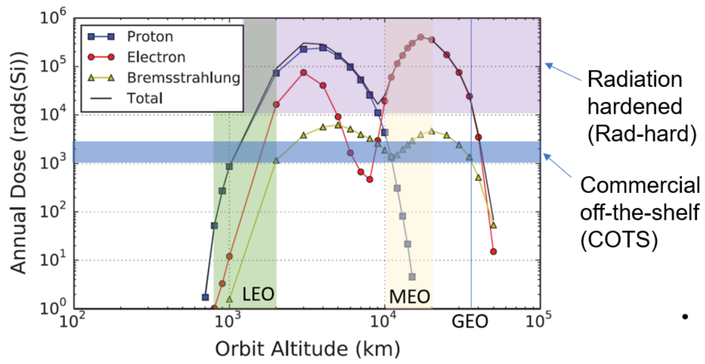


Image Source: University of Liège.

- Bulk Al shielding thickness depends on the electronics with the least radiation resistance



Reproduced from Wulf et al., *ACM Trans. Reconfigurable Technol. Syst.* **10**,1-29 (2016).

- Rad-hard part are still needed at certain orbit heights

COTS (MAX32675ATK+)	Rad-hard (VA41620)
$10.26	$3,912.17

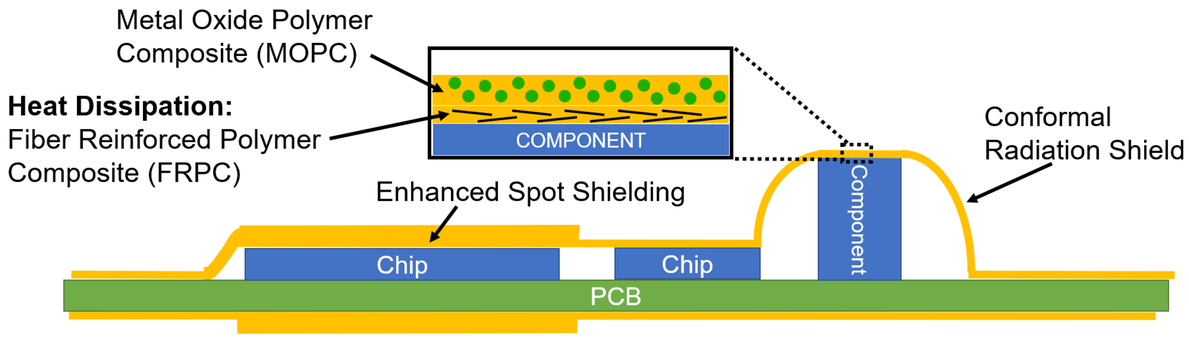
Source: Mouser.com

- Rad-hard parts: expensive and long lead time
- Advanced electronics are COTS-only

→ Need space radiation shield with low Size, Weight, and Power (SWaP) requirements

CONCEPT

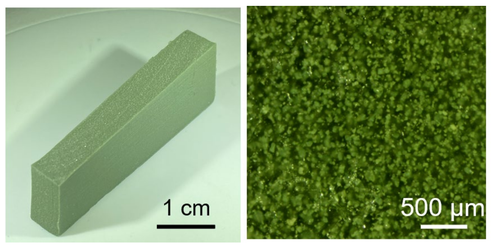
A 3D-printed lightweight polymer radiation shield with an integrated heat dissipation layer



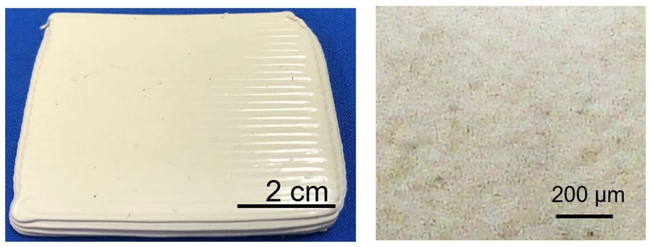
- One system for both radiation and thermal challenges
- MOPC with High-Z metal oxides particle
  → **Enhanced electron attenuation**
- FRPC with carbon fiber
  → **Improved heat dissipation**
- 3D printing enables spot radiation shielding
  → **Allow COTS parts w/ low SWaP requirements**

RESULTS AND DISCUSSION

MOPC Development and Testing

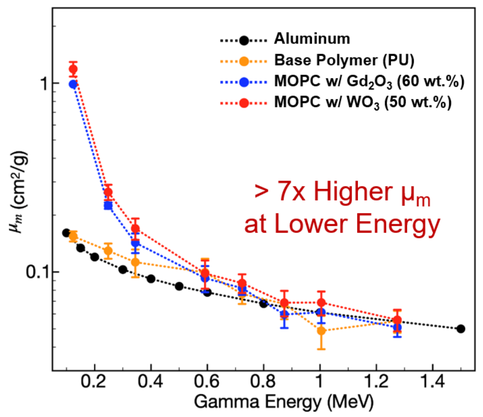


MOPC with WO_3 – Casting



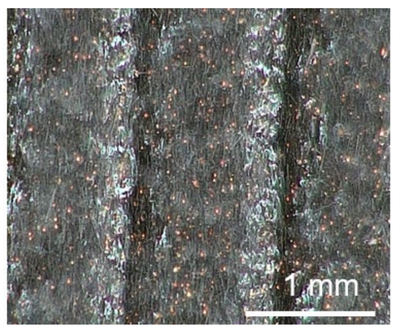
MOPC with Gd_2O_3 – 3D Printed

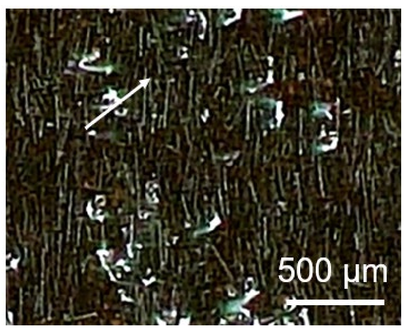
- High quality MOPC samples



- Gamma ray radiation measurements: >7x radiation attenuation coefficient
- MCNP6 modeling shows 18% - 25% weight reduction compared to Al

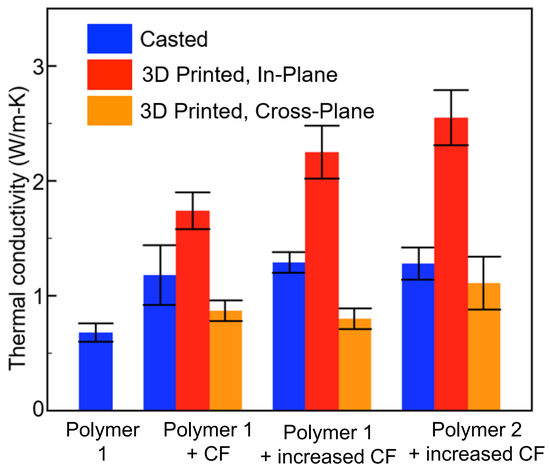
FRPC Development and Testing



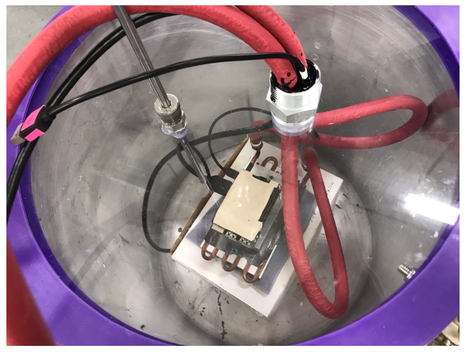


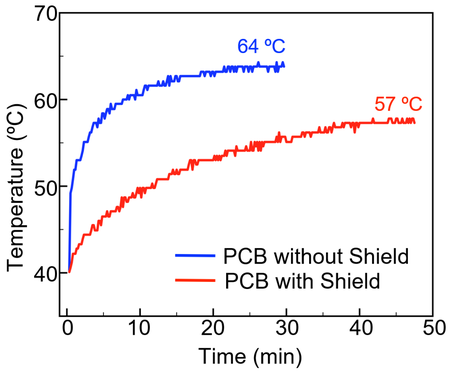
FRPC with aligned carbon fibers – 3D Printed

- 2.55 W/m-K in-plane thermal conductivity



Shielding Prototype TVAC Tests





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