A Novel Production Method of Millimeter-wave Absorber with a 3D-printed Mold

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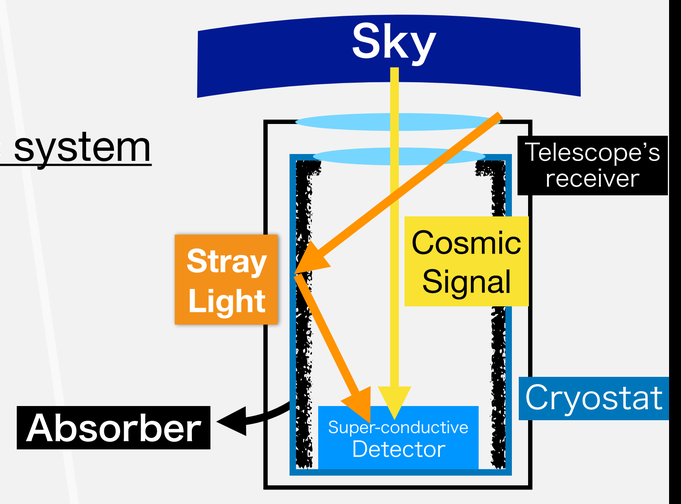
Motivation

- To suppress **"Stray Light"** in radio telescopes
- **Requirements** for the absorber used in a cryogenic system
  - High absorption rate
  - **Low reflectance on the surface**
  - **Good performance in cryogenic condition**
    - cold resistance
    - thermal conductivity
    - Optional: Adhesion performance on metal

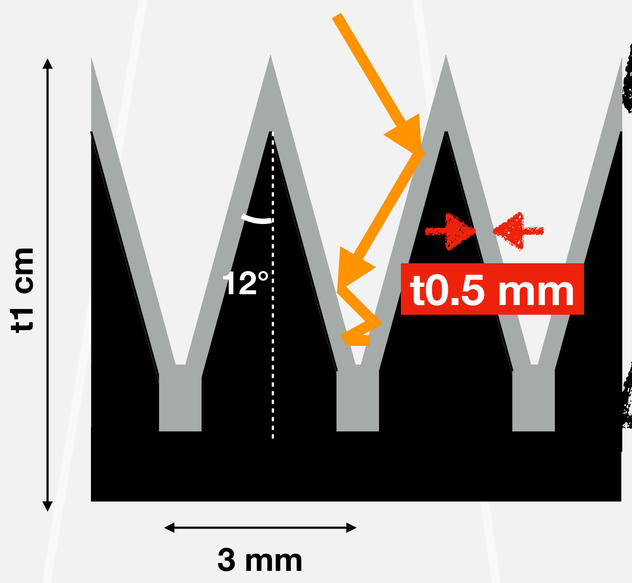


Sample

New Production Method

We propose a new production method of an absorber with **periodical pyramid surface** shaped by a **3D-printed mold**

Decrease reflectance on the surface



3D-Printed Mold

- Make pyramid surface
- Sufficient thin & less absorptive to ignore its optics effect
  - **Does not need to be removed**

Absorptive material

- Actual absorber
- Pyramid shaped

Advantages:

1. Quick R&D / mold fabrication

- Fabrication of the 3D printed mold is short period from design to fabrication. (1 fab. iteration ~ one week)
- Easy to make various shape absorbers to adjust a mounting point in the telescope.

2. Ability to select the absorptive material

- By using a material suitable in cryogenic system, the absorber gets good cryogenic performance.

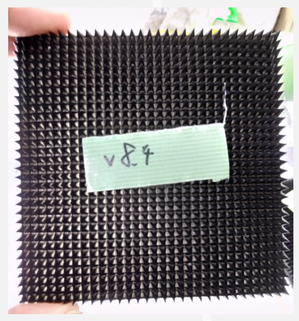
Prototyping

3D-printed mold

PolyJet 3D-printer
of Stratasys Japan Ltd.

- **Good fineness: ~30 μm**
- **Quick fabrication** due to its layer-by-layer fab.
  (like ink-jet paper-printing)
- Less absorptive:
  ~50% wt t10mm @ 100 GHz

10cmx10cm sample
(mold only)

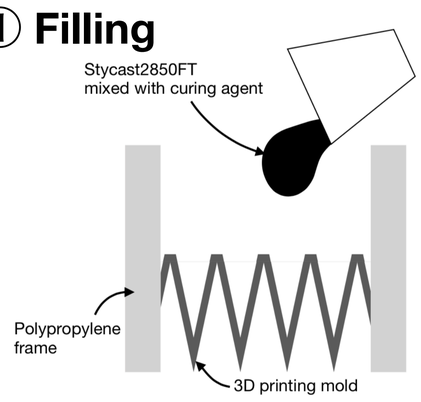


Absorptive material

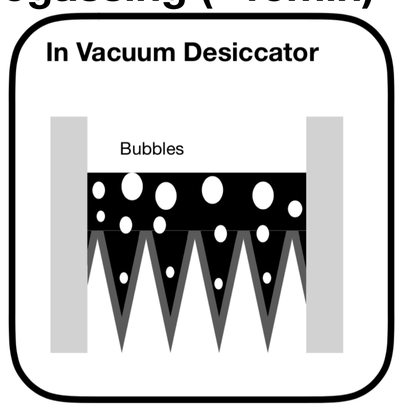
Stycast2850FT

- **Good adhesive performance**
  in low temperature (CTE agreement with aluminum)
- **Good thermal conductivity** (~64mW/mK @ 4K)

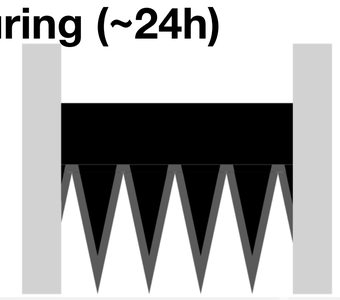
① Filling



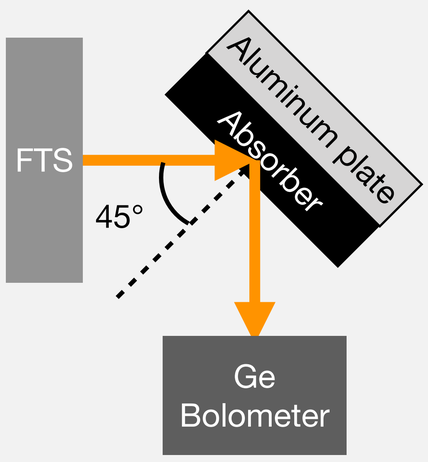
② Degassing (~15min)

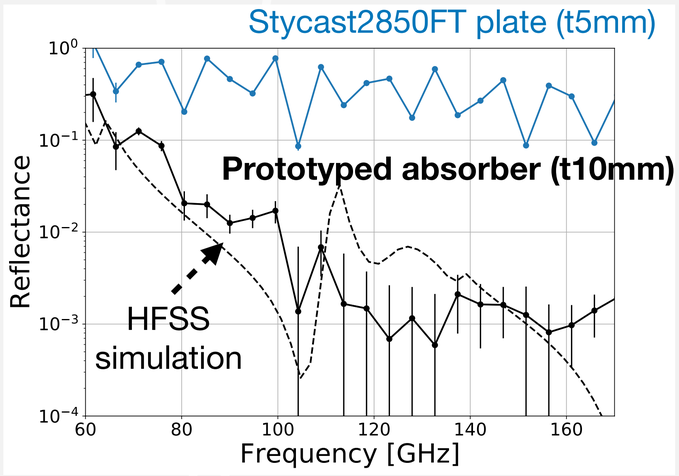


③ Curing (~24h)



Reflectivity Measurement





- Incident angle : 45°
- Frequency range : 60~170 GHz
  by using a FTS (Fourier Transfer Spectrometer)

- **Reflectance < ~1%** [@ Frequency > 100 GHz]
  - 1/10 better than the flat Stycast2850FT plate (~*O*(10%))

Cryogenic Test

- 3 times liquid N_2 dunking
  A 10x10cm prototype is adhered to an aluminum plate (t1 mm)

- **There is no crack.**
- **Does not peeled off the aluminum plate**

Conclusion

The new absorber production method by 3D-printed mold has good optical performance & cryogenic performance. Its advantages are **quick R&D** and the **selectable absorptive material**, which make easy to optimize the absorber for each application.

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