

OPEN

Compute Project



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Use of Alternative Natural Fiber-Filled Polypropylene (NFFPP) Plastic in Data Center Equipment Design to Improve Sustainability

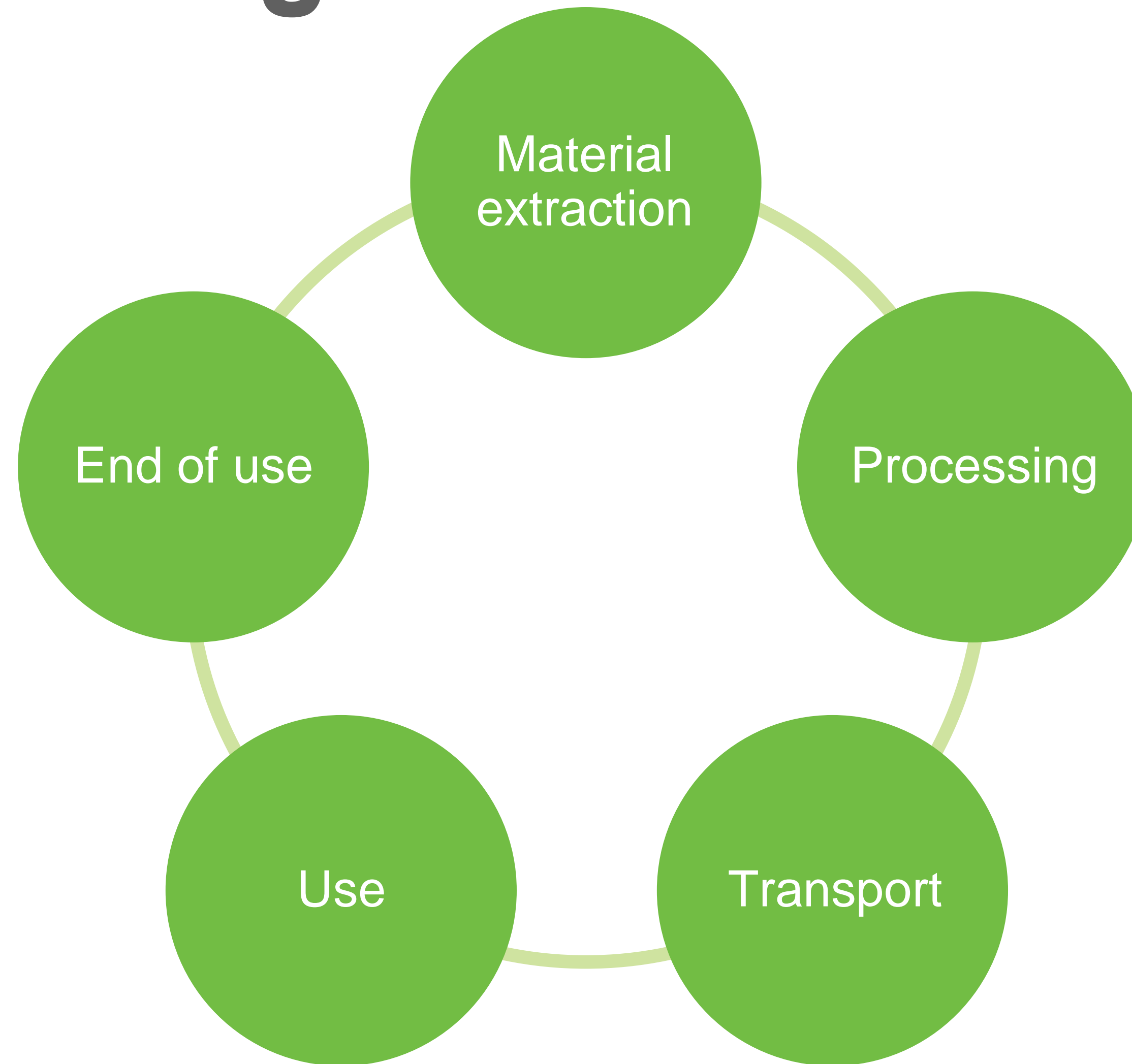
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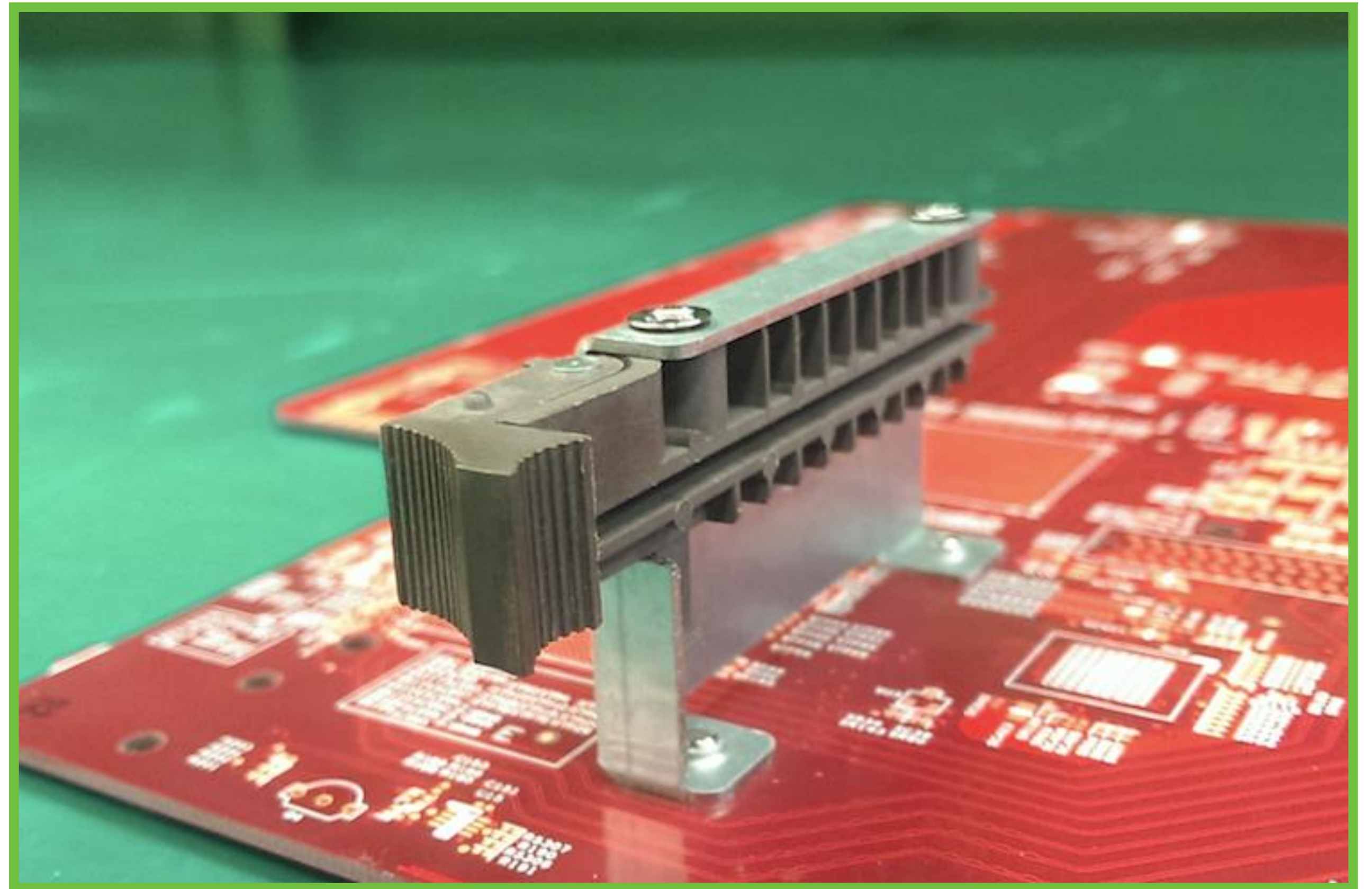
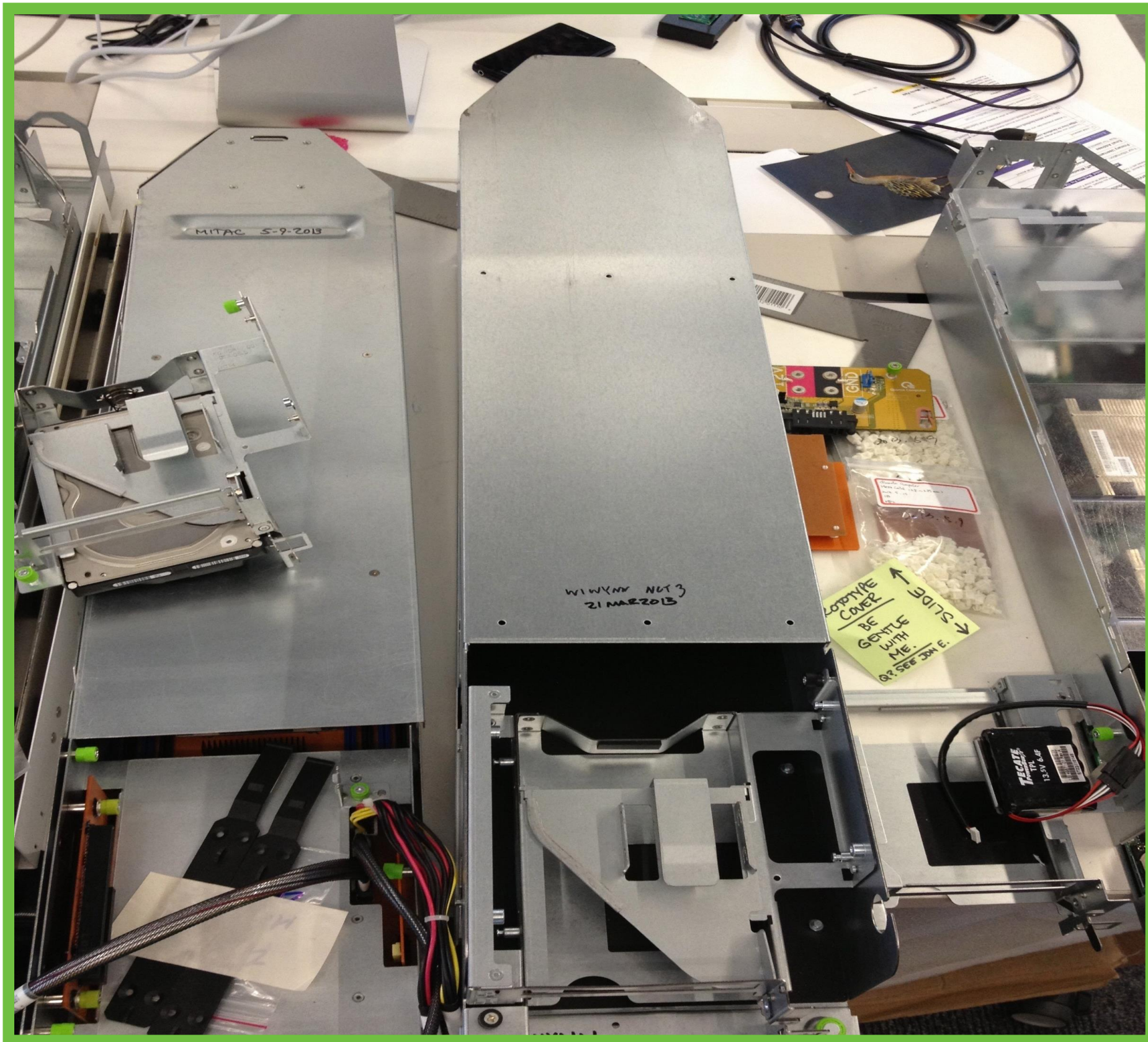
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Life cycle design



Hack turned opportunity



Natural fiber-filled polypropylene



Natural fibers



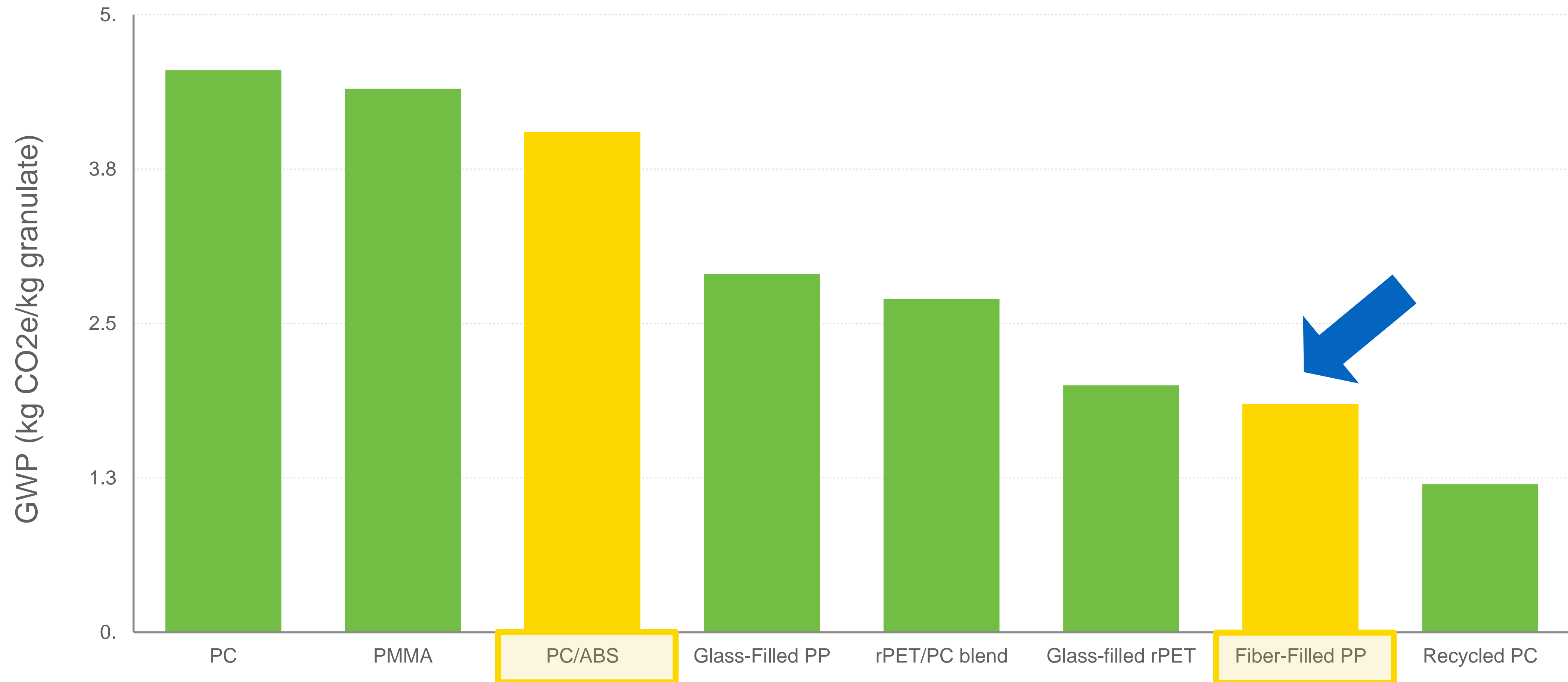
Polypropylene

NFFPP compared to PC/ABS

Material	Tensile strength (kpsi)	Best available UL94 rating	Carbon footprint (kg C02/kg granulate)	Key features
PC/ABS	7-10	V0	4.05	<ul style="list-style-type: none">• High environmental footprint• Derived from oil; sensitive to price shocks• High price due to high cost of PC• Concern about Bisphenol A releases in PC supply chain
PP/NF	5-9	V0	1.87	<ul style="list-style-type: none">• Low environmental footprint• 35% rapidly renewable material• PP derived from natural gas; decreasing price• Less dense: Lower material use and lower shipping costs

Carbon footprint

(Material acquisition to resin)



Other applications



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Mechanical Engineering

Jon Ehlen

MECHANICAL ENGINEER, FACEBOOK

NFFPP benefits

- Flame retardant is UL 95 V-0, V-1, V-2 compliant
- Available in black, natural brown, green, red and other colors
- Various options for stiffness/flexibility
- Shrinkage is almost the same as (PC+) ABS – can share the same tool
- May be recycled in pellet form to create new parts
- Alternatively, incinerated, the material burns “cleanly” without outgassing or introducing toxins into the atmosphere

How Facebook uses NFFPP



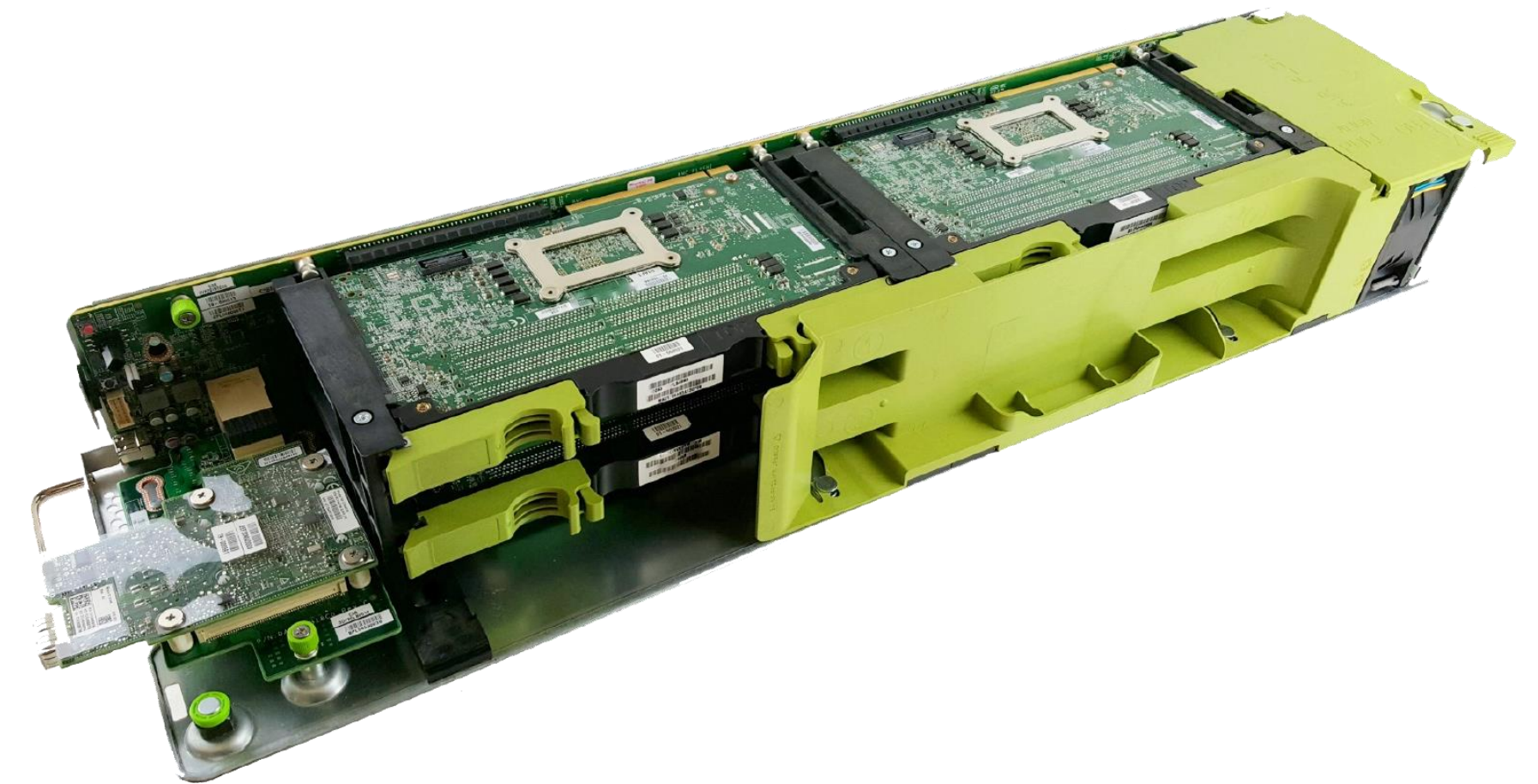
→ Currently used in mass production on various OCP systems:

- Lightning
- Honey Badger
- Yosemite (converted from PC+ABS using PC+ABS tooling with minor tweaks)
- Open Rack (bus bar cover and cable clips)
- Knox (HDD adapters)

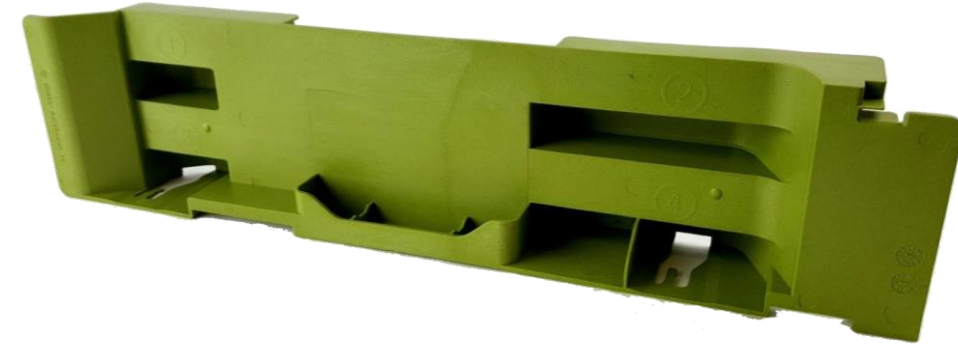
→ To comply with Facebook sustainability goals, all new products will use a version of NFFPP material unless design requirements force the use of a different plastic material

Yosemite (4 CPU card server chassis)

- Originally designed for PC+ABS
- Tooling was used to convert to NFFPP plastics
- Tooling changes needed were minor:
 - Addition of ribs to help prevent tall, thin walls from warping
 - Lowering of thin, tall walls by ~30%
 - Thickening of small snap features
 - Addition of one fan gate in fan tray air baffle to prevent warping
- Each part needed to have the molding process parameters defined



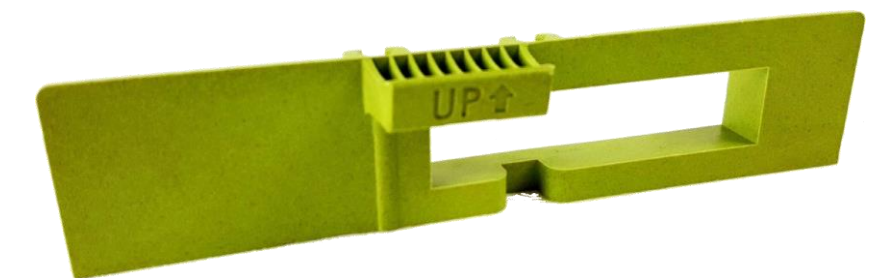
How Facebook uses NFFPP



Cardguides

Air baffles

Structures



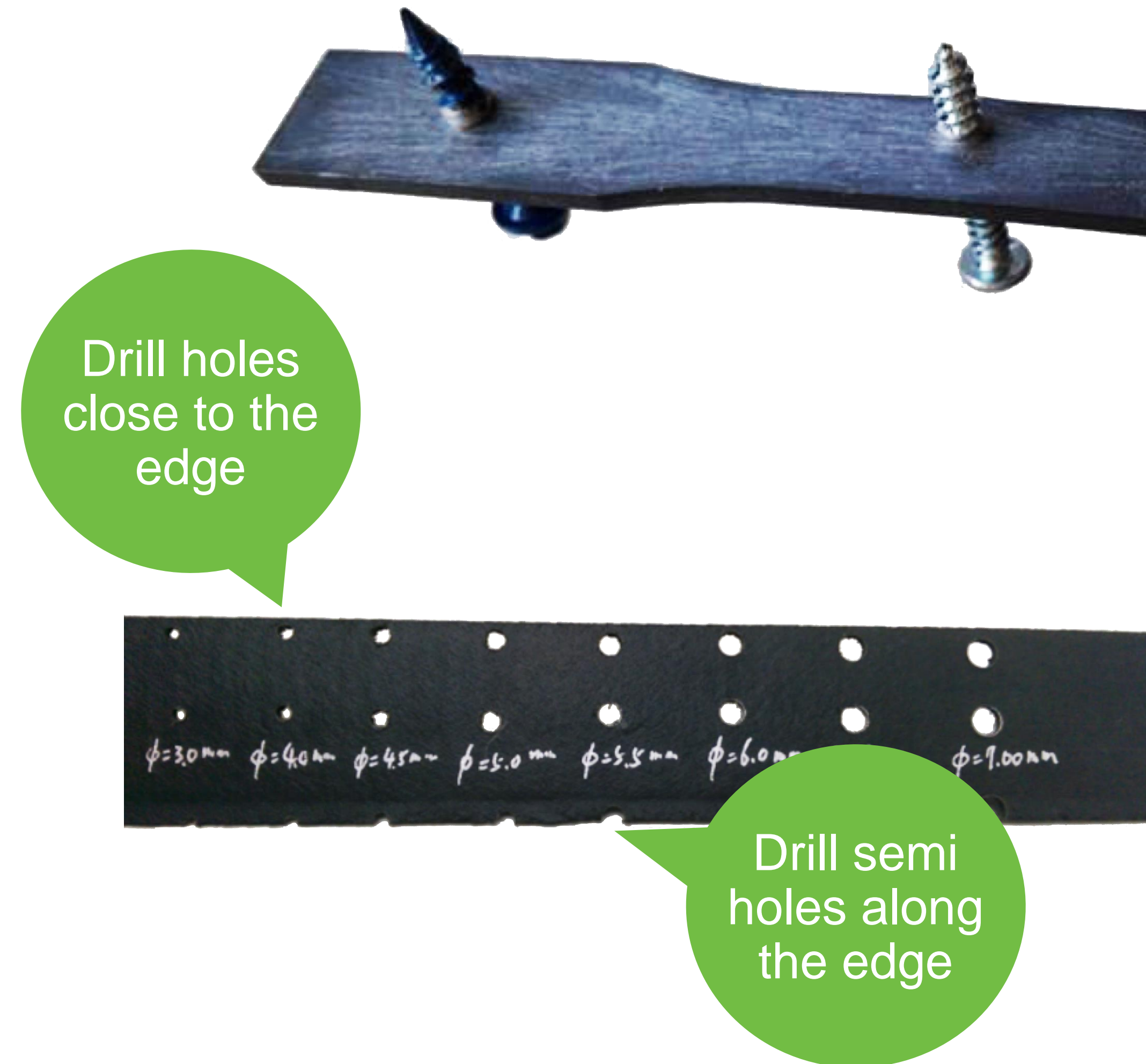
How Facebook uses NFFPP

- Adapters with spring fingers
- Internal server cable management
- Springs can be designed as long as deflection is not severe or under permanent use
- Long spring fingers may deform during cooling – this can be corrected by doubling the deflection distance in the spring design
- Cal also be corrected by using a cooling fixture to set the spring to nominal



Thread forming screws

- High flex NFrPP331FR (-BK color) was originally developed for use in Facebook rack cable clips but is also useful if you want to use thread forming screws
- 331 is less brittle than 325 when self threading screws are used, and holds the screws firmly, especially for smaller and delicate parts
- Currently used this way in Honey Badger and Yosemite products



Part marking

- Facebook marks our parts with the #7 (other) symbol, the resin manufacturer's name and resin designation to aid in separation for future recycling at EOL



Tooling and design considerations

- Refer to GFRP or CFRP (Carbon Fiber Reinforced Plastics) design rules for reference
- Increase the number of gates
- Large, evenly distributed gates will help in holding pressure and reduce cosmetic surface fiber streaks
- Add grid ribs on thin, long, or large area flat parts
- Add sufficient draft angles for easier ejection and lower warpage
- Evenly distributed ejector pins will also help reduce warpage
- Tool wear is similar to GF resins

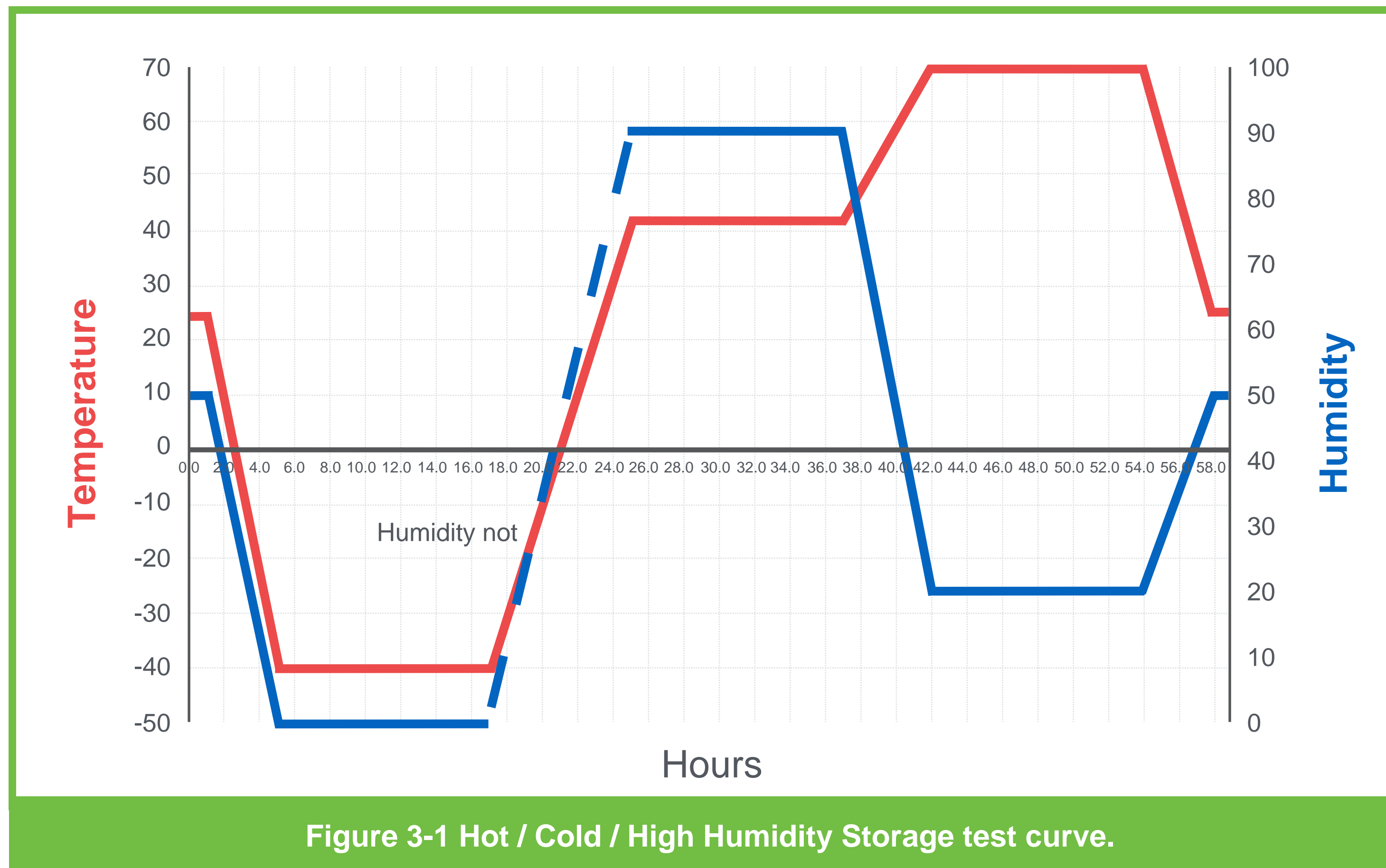
Storage and environmental testing

Test Specifications

-40°C ~70°C / 20%~90% R.H, Max. Wet-bulb temp.: 40°C with Non-condensing

Notes: (1) Temperature and humidity gradient should be 20°C / hour 20% R.H. / hour respectively to prevent condensation

(2) Above humidity is non-condensing



Storage and environmental testing

SSD adapter, Honey Badger baffle and cable clips:

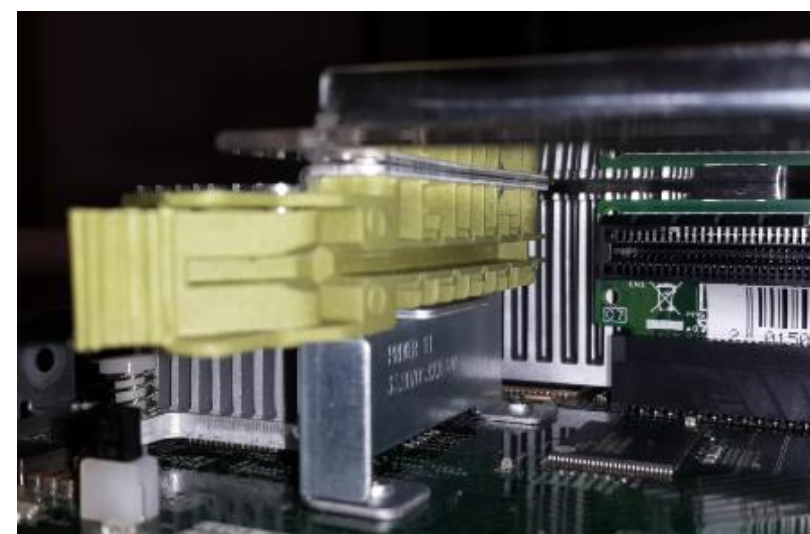
- Pre-cleaned, poly-wrapped SSD adapter included for observation of white powder issue; none observed
- No color change or deformation in samples



Storage and environmental testing

NFrPP material with PCB and metal bracket

- There's no interaction between card guides and PCB or metal brackets
- Function of baseboard and Panther+ is normal after test



Left card guide



Base Board and Panther +



Right card guide

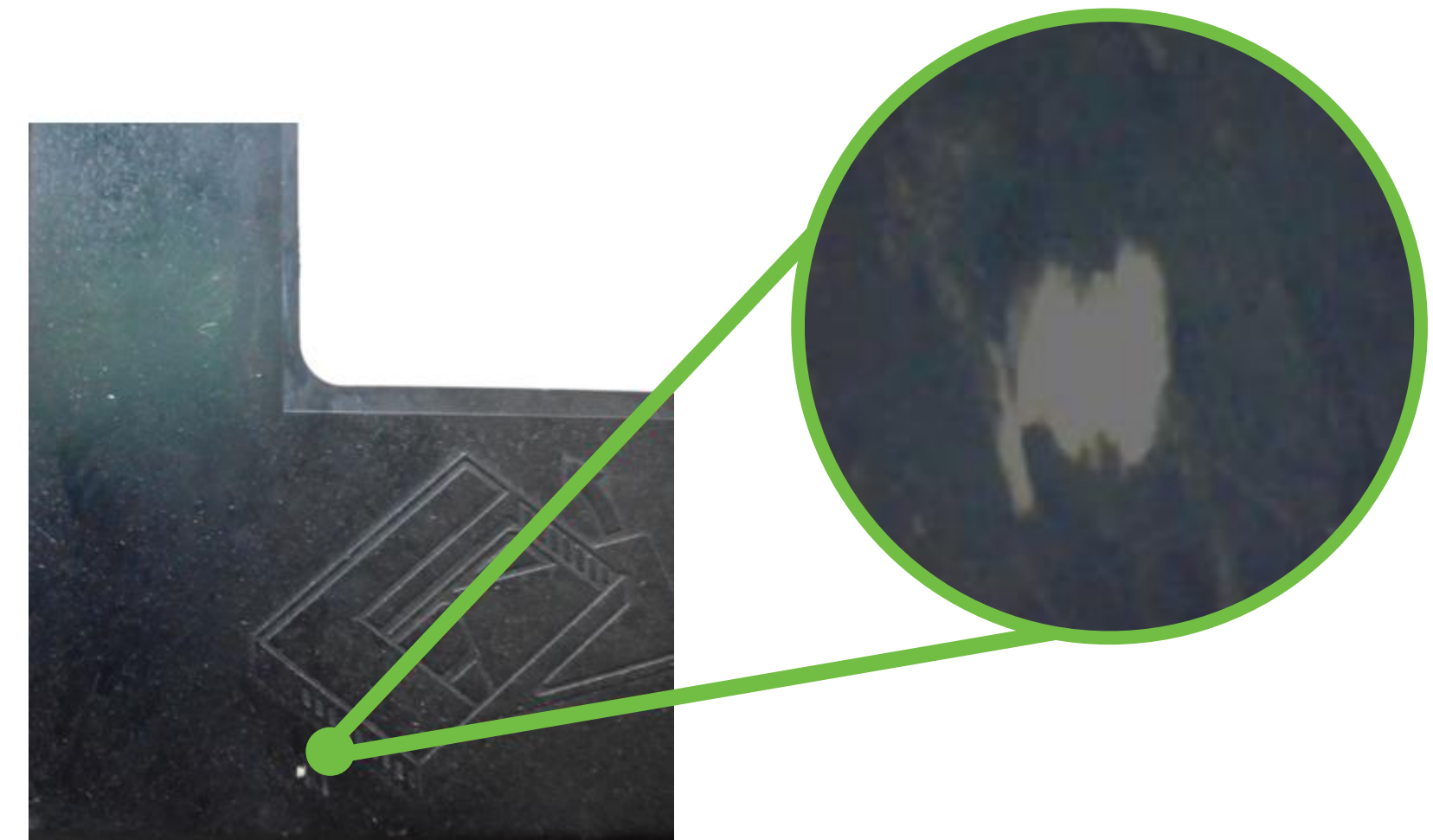
Process configuration

- Unlike PC+ABS, NFFPP needs a well tuned initial setup procedure
- Do not rely on the water heater settings – measure the couplings, and interior mold temperatures
- Important for successful molding:

Injection pressure	Injection speed	Hold time	Injection barrel heaters/temperature
Mold surface temperature	Injection point temperature	Water heater couplings/mold couplings	Dehumidification of pellets is critical – don't rush this step

Dehumidification of resin pellets

- Pellets must be dried per specifications to release trapped moisture
- Issue is cosmetic only, and manifests as white marks or a thin white powder on the part surface



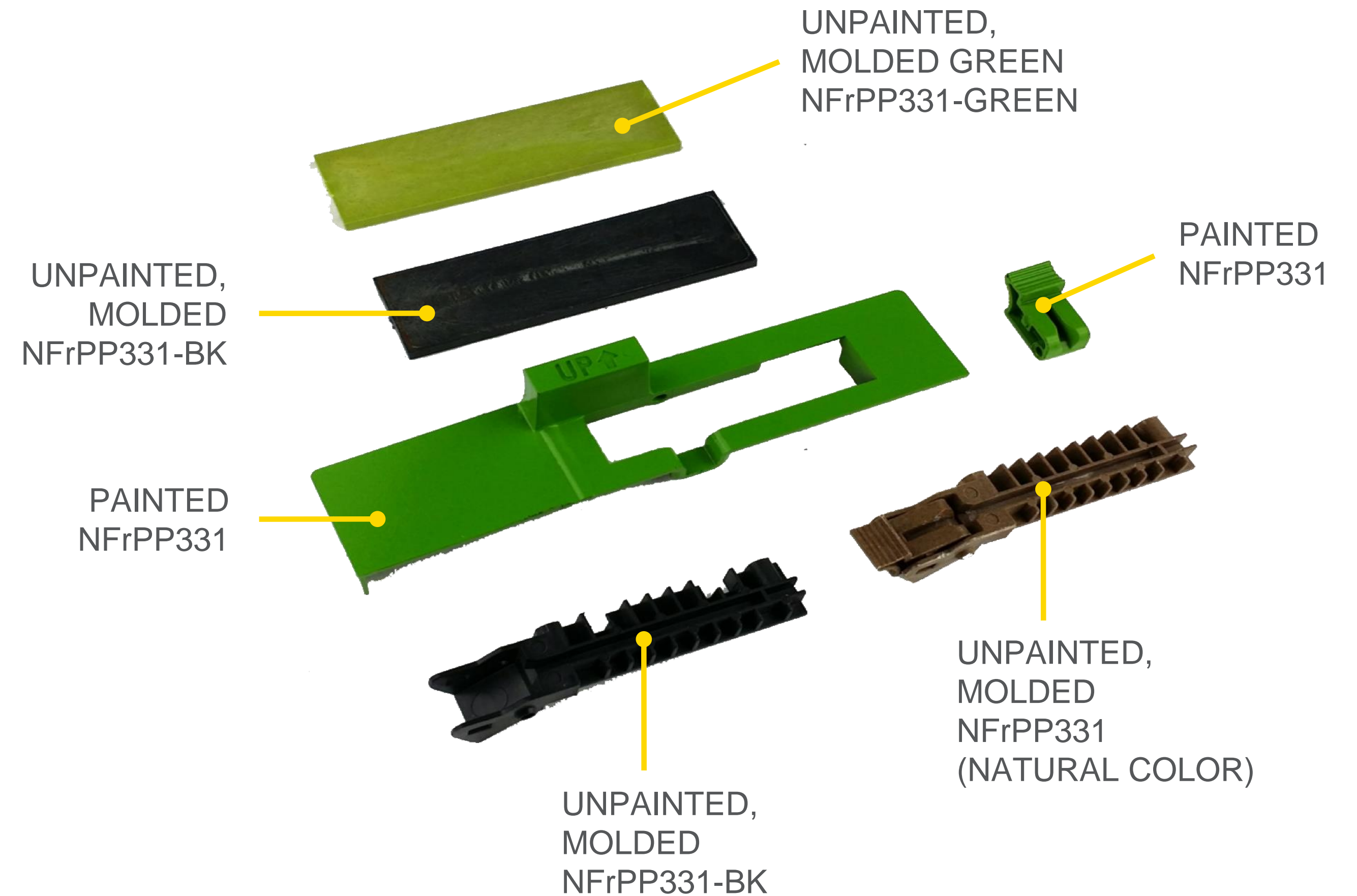
Coloration and surface cosmetics

- The nature of the natural fiber fill allows fiber flow marks to be seen in the surface of the part
- This is largely hidden in darker colored parts, especially black
- Most noticeable in natural (non-tinted) resin



Painting

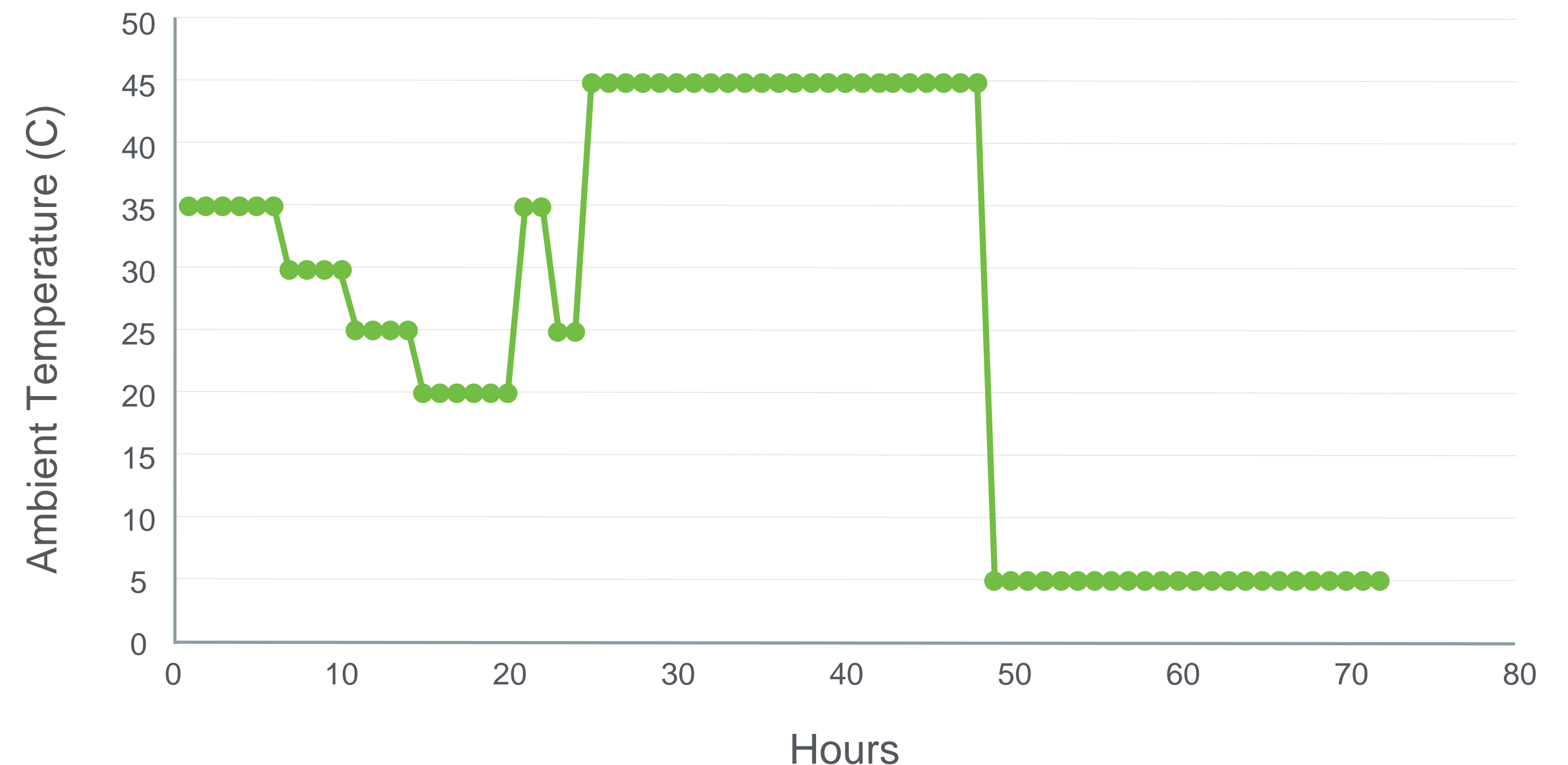
- Can largely be treated as PP for painting
- Painting is possible: need proper surface treatment
- Passes nail scratch test but is marginal for criss-cross paint adherence test
- Painted part yield was low in our trials



How Facebook uses NFFPP

Use with 3M PSA adhesives

- The NFFPP works well with 3M VHB brand double sided adhesive
- There is no measurable difference in tensile or shear strength on either adhesive side after environmental testing



Resin options

Part number conventions: NFrPP331FR-BK
NFr = natural fiber reinforced
PP = polypropylene
331 = resin number (sequential)
FR = UL 94 V-0 flame retardant
-BK – color (black)

Items	Unit	Method	NFrRPP313	NFrRPP325FR	NFrPP327FR	NFrPP329FR	NFrPP32FR
Tensile Strength	kgf/mm2	ASTM D-638	2.8	3.6	2.2	3.1	2.0
Elongation at Break	%	ASTM D-638	4.5	4.9	2.5	4.6	8.6
Flexural Strength	kgf/mm2	ASTM D-790	3.6	4.6	2.6	3.7	0.2
Flexural Modulus	kgf/mm2	ASTM D-790	236.9	120.0	206.0	326.2	14.9
Izod Impact	j/m	ASTM D-256	39.5	44.9	40.6	37.2	89.6
HDT 66psi	°C	ASTM D-638	145.0	142.8	150.0	145.8	108.0
Melt Flow Rate	g/10 min	ASTM D-1238	3.0	3.0	3.5	3.0	3.0
Mold Shrinkage	%	ASTM D-955	0.3~0.5	0.3~0.5	0.3~0.5	0.3~0.5	0.3~0.5
Density	g/cm ³	ASTM D-792	1.37	0.983	1.08	1.37	1.37
Flame Retardance	UL-94	VO		V0,1.6mm	1.6mm	1.6mm	1.6mm

Our Approach and Goals

➔ We approach hardware design by keeping the entire lifecycle in mind

➔ Minimize carbon footprint and impact of our products.

NFFPP can help improve this by > 50% as compared to PCABS parts.



Material vendor information

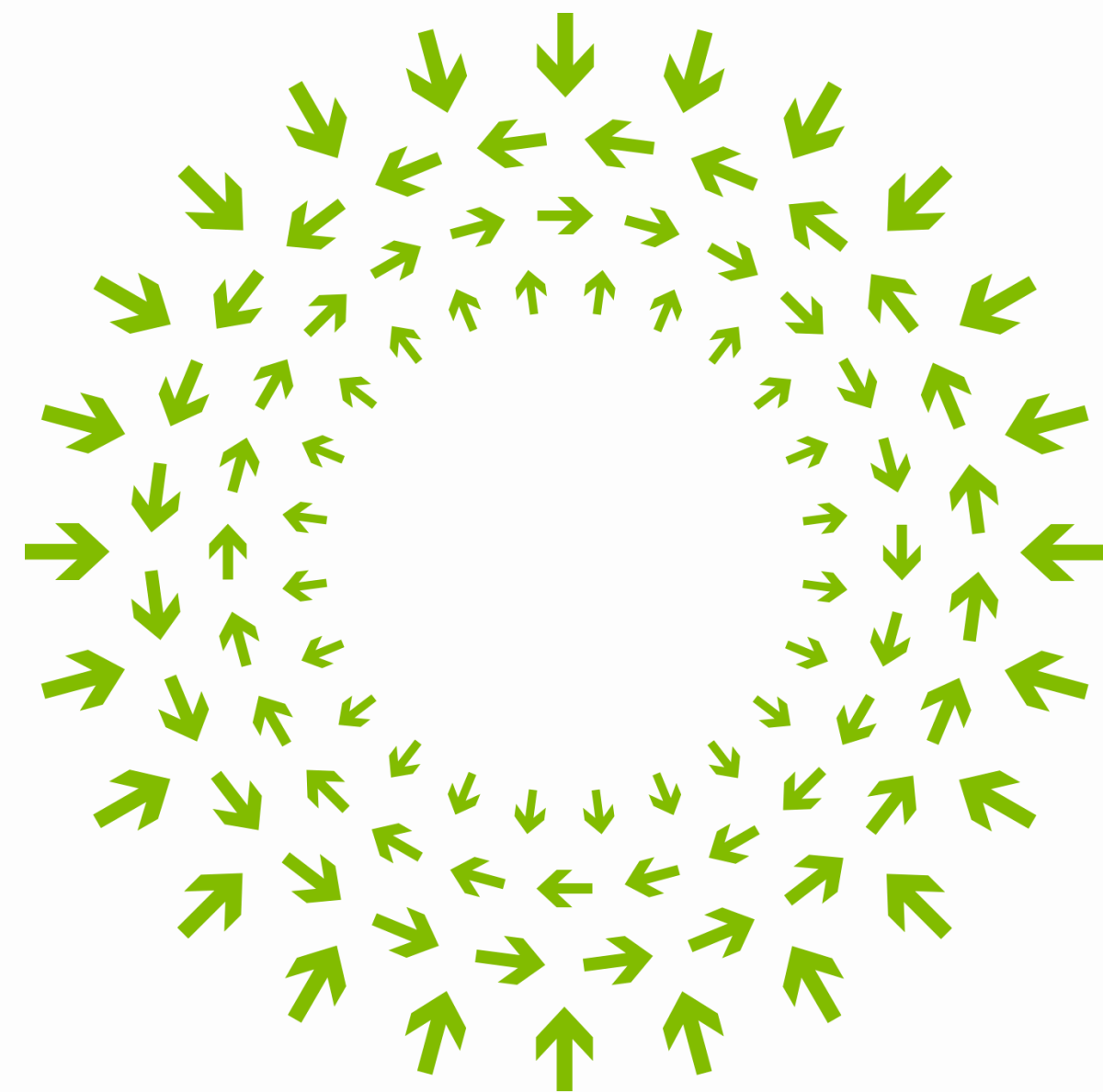
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