Material Comparisons

We live in a fantastic world to have literally hundreds of colors available in dozens of different materials for hobby 3D printing

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TPU *"Thermoplastic PolyUrethane"*, TPE *"ThermoPlastic Elastomer"*, Flexible-PLA, etc.

- Softest material straight from a filament printer
  - Has more in common with rubber than plastic
- Best impact resistance
- Adequate temperature resistance
  - Innate flexibility allows its use well above the glass transition temperature

- Moisture
  - **TPU and TPE filaments MUST be dry!**
  - Moist filament has horrible print quality
  - Weaknesses are created in each layer by Steam bubbles

- Uses
  - Anything that needs to be flexible or survive regular & significant impacts
  - If the low temp and flexibility aren't problems, this can be used in place of many other plastics

- Issues
  - Flexibility, stretch, compression, etc. are REAL problems for some extruder styles
    - Bowden systems can usually deal down to 95a shore hardness materials if printed SUPER S L O W
    - Multi-Material systems can RARELY deal with 95a materials (MMU, Palette, AMS, etc.)

- **My Opinions**
  - Medium to poor aesthetic print quality when compared to other filament materials
  - Printing flexible materials can offer many new possibilities for home 3D printers
    - Rubber mallet, corner bumpers, cane tips, protective cases, etc.

ABS "Acrylonitrile Butadiene Styrene"

- Requires higher temperature "All Metal" hot end
- Negative issues
  - Warping - Ambient closer to Tg helps
  - Possible layer delamination- Ambient closer to Tg helps
  - Noxious off-gassing - Enclosed printing with internal carbon filter or after-print venting helps
- Prefers enclosure/print chamber to be kept around half it's glass transition point (~50c)
- Any plastic containing Styrene stinks when printing and reacts with Acetone

Post-processing

- Can be Vapor Smoothed using Acetone for glassy smooth prints
- Sands nicely by machine if kept cool, sanding by hand can be dusty
  - Recommend wet sanding when possible
- Painting protects the plastic from UV deterioration and fills in layer lines

My Opinions

- Mostly seal a 3d printer into an enclosure to keep both Heat and Stink inside while printing
- Thin nylon photography tents might be OK if the room is already REALLY warm but they loose heat quickly
- Thin plastic sheeting works better than nylon but suffers from poor insulation qualities if ambient temp is cool
- Large cardboard box worked great but I didn't like unfolding the flaps to touch printer each time
- IKEA LACK table with foam-core craft board walls/door made for excellent insulation

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ASA "Acrylonitrile Styrene Acrylate"

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PLA "PolyLactic Acid", PLA+, PLA-Pro, etc.

- Stiffest material
  - Generally bends less easily than other materials
- Hardest material
  - Resists deformation by a pointy thing better than most (at least to start with...)
- Very poor temperature resistance
  - Prints left in a hot car will likely deform
- Very poor impact resistance
  - PLA Hammer + Nail = Plastic Shrapnel
- Very poor creep resistance
  - PLA shelf bracket + (insert time) = Shelf on floor
  - I use PLA for a ton of things, but when it MUST hold weight, I use PC or PA depending on impact requirement
- "+" and "Pro" modifiers vary wildly between manufacturers
  - **Test EVERY new material;** Make no assumptions about the modifiers or their expected properties

Deterioration

- Increased stringing with more moisture typically, but usually very mild compared to PETG, TPU, etc.
- Embrittlement with extended moisture or Ultraviolet light exposure
  - These traits seem to follow the base material rather than the additives or colorants
  - Some transparent, translucent, or silk filaments seemed to be significantly less affected

Post-processing

- Sanding PLA is *SLOW!* - If sanded too briskly the dust melts back onto the part, ruining the surface
- 3D Gloop is the only "consumer accessible" smoothing agent for PLA - Industrial chemicals are available
- Painting protects the plastic from UV deterioration and fills in layer lines
  - Lighter colors absorb less heat
  - Glossy finishes absorb less heat

- Uses
  - Anything that will live inside a home (No UV and low heat)
  - No large physical stresses placed upon it (Creeping over time)
- Known Exceptions (to the normal rules)
  - Protopasta HTPLA *(High Temperature Polylactic Acid)*
    - Prints like normal PLA then heat treated at increasing temperatures to get ~100c heat deflection temp!
    - Warpage during heat treat process can be an issue for some part geometries
    - https://proto-pasta.com/pages/high-temp-pla
  - Lay-Filaments Reflect-O-Lay Flexible PLA
    - Prints and physically acts like soft (<90) TPU/TPE
    - Feels somewhat "fuzzy" and a lot like rubber
    - Crazy retroreflector effect
    - http://lay-filaments.com/LayFilaments-Overview+LightMeta5-b.pdf
- **My Opinions**
  - Best for aesthetic print quality
  - Seems to "creep" under any significant stresses
  - Favorite material for prototyping $$$ *(prototypes become finished products when they work the first time)*

PETG, PETG+, PETG-Pro, etc.

- Prints on most printers capable of PLA
- Adequate temperature resistance

PC

- Requires higher temperature "All Metal" hot end
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PP

- Requires higher temperature "All Metal" hot end
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PA, Nylon, etc.

- Requires higher temperature "All Metal" hot end
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PE

- Requires higher temperature "All Metal" hot end
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More to come...

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