Physical Modelling for Electronics Enclosures Using Rapid Prototyping

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Lecture - 26
Materials

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It looking ugly because lot of our life depends on identifying things by shades of colour, so when UV happens the colour changes compatible with you shall know which heat up to 220 such as so on and so on like that next one is.

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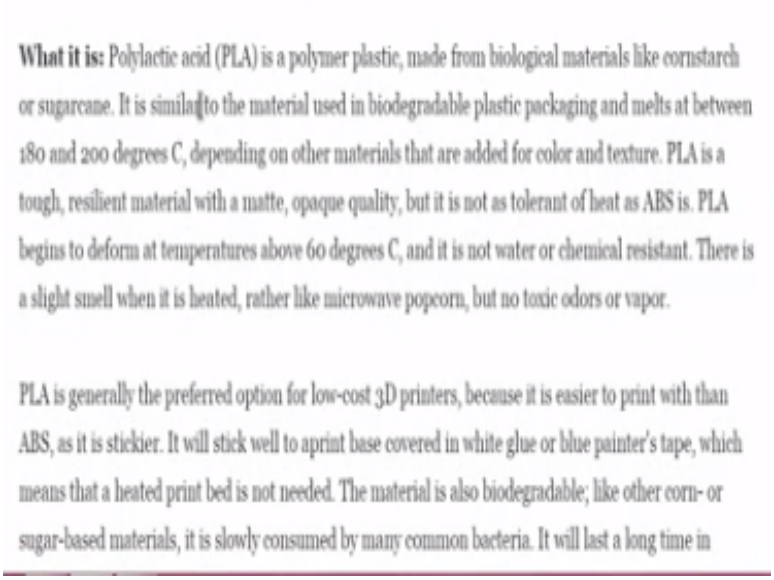

What it is: Polylactic acid (PLA) is a polymer plastic, made from biological materials like cornstarch or sugarcane. It is similar to the material used in biodegradable plastic packaging and melts at between 180 and 200 degrees C, depending on other materials that are added for color and texture. PLA is a tough, resilient material with a matte, opaque quality, but it is not as tolerant of heat as ABS is. PLA begins to deform at temperatures above 60 degrees C, and it is not water or chemical resistant. There is a slight smell when it is heated, rather like microwave popcorn, but no toxic odors or vapor.

PLA is generally the preferred option for low-cost 3D printers, because it is easier to print with than ABS, as it is stickier. It will stick well to a print base covered in white glue or blue painter's tape, which means that a heated print bed is not needed. The material is also biodegradable; like other corn- or sugar-based materials, it is slowly consumed by many common bacteria. It will last a long time in

You see the other one, seen this here may be a little bit of reality will this thing, this is the support material, then this is the base material and this is the usual thing, which people use when print with MakerBot. What is this? This is the PLA material. PLA is polylactic acid stuff made from biological materials like corn starch and sugarcane. Similar to the material used in degradable plastic packaging and melts at between 180 and 200.

Compared to that it is 100 degree slower depending on other materials that are added for colour and texture. It is a tough resilient material with a matt opaque quality you seen that know. Issue is instead of it being reflective, if it is matt, any matt surface hides defects. Any reflective surface highlights the defects. So, any small changes in variation, small changes in thickness or in case there is any shrinkage or warpage and all it will be highly visible in the case the material is reflective.

And you see here, it is not as tolerant of heat as ABS or PLA above 60 and it is not water or chemical resistant.

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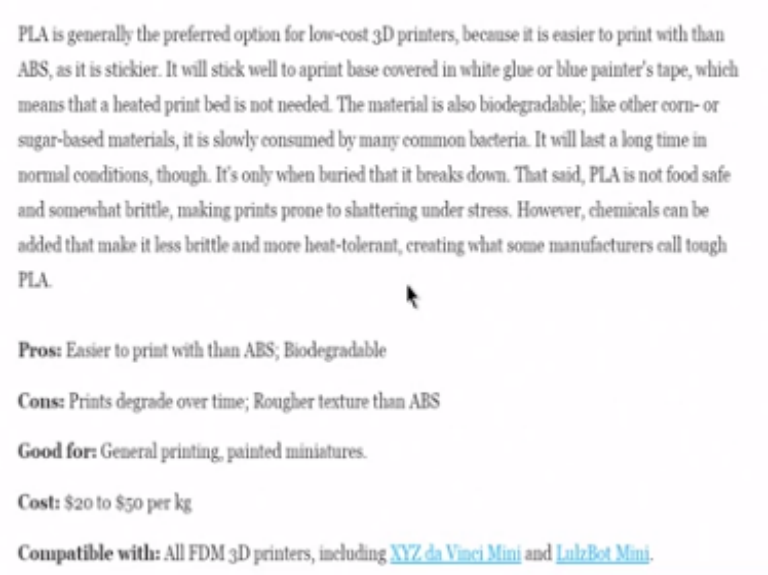
PLA is generally the preferred option for low-cost 3D printers, because it is easier to print with than ABS, as it is stickier. It will stick well to aprint base covered in white glue or blue painter's tape, which means that a heated print bed is not needed. The material is also biodegradable; like other corn- or sugar-based materials, it is slowly consumed by many common bacteria. It will last a long time in normal conditions, though. It's only when buried that it breaks down. That said, PLA is not food safe and somewhat brittle, making prints prone to shattering under stress. However, chemicals can be added that make it less brittle and more heat-tolerant, creating what some manufacturers call tough PLA.

Pros: Easier to print with than ABS; Biodegradable

Cons: Prints degrade over time; Rougher texture than ABS

Good for: General printing, painted miniatures.

Cost: $20 to $50 per kg

Compatible with: All FDM 3D printers, including XYZ da Vinci Mini and LulzBot Mini.

There is a slight smell when it is heated and so on. It is preferred for low cost 3D printers because it is easier to print than with ABS as it is stickier. It will stick well to a base which is covered in white glue or blue painter strip, which means that heated print bed is not needed. Material is also biodegradable like other so on and all that. Often, is not food safe and somewhat brittle making prints prone to shattering under stress.

So, usually a combination of this PLA is just used as a support material, which when particular combination where it very easily dissolves in water and the main object at the top is print the main build material which is tough and made with other options. So, the advantage is after this job is made, if we just put it in a water bath at a higher temperature, temperature which is between this softening and this is what you call the highest what do you call softening temperature.

And if you leave it soaked for 24 hours, it is easy you can snap off the parts seen this know. This is the second preferred material.

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A print made with ABS print material and PVA supports with the Ultimaker 3

What is it: Polyvinyl alcohol (PVA) is one of a new class of 3D printing materials that are used to make supports that hold 3D prints in place. A synthetic polymer, PVA is water soluble. It melts at about 200 degrees C, and can release some nasty chemicals if heated to higher temperatures.

This is why PVA is used in 3D printing. It can be used in a standard 3D printer extruder to form parts that support other objects, and it sticks to a heated, glass print bed well. Once the printing is complete, you immerse it in water, and the PVA parts will dissolve, leaving the rest of the insoluble print behind. This makes it easier to print complex models that require supports, or even models that include moving

They have given everything, prints degrade rougher texture than ABS or general printing and painted miniatures.

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This makes it easier to print complex models that require supports, or even models that include moving parts. If you do use water to dissolve PVA, you'll need to properly dispose of it, as the sticky residue can clog drains. Check with your local water company for the recommended disposal method.

Pros: Water soluble; Good for supports; Fairly easy to print

Cons: Can release toxic vapors if overheated; Expensive; Requires appropriate disposal

Good for: printing complex models with PLA or ABS

Cost: More than $100 per kg

Compatible with: Standard FDM printers with multiple extruders, such as the Ultimaker 3

Next, we come to PVA. Polyvinyl alcohol material is a new class of 3D printing materials that are used to make supports that hold 3D prints and place a synthetic polymer PVA is water soluble. While I told you the one there saying that PLA is used, right now everything is slowly being changed to this PVA. The advantage being it can be used in a standard printer extruder to form parts that support other objects and after this thing is over know, you put it in water and soak it.

PVA parts will dissolve living the rest of the insoluble print behind. This makes it easier to print complex models that require supports or even models that include moving parts. If I do this water to dissolve, you will need to properly dispose off as a sticky residue can clog drains and so on.

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So, we have all the stuff which is you know, these three are the very, very common things which is used there and if you remember I showed you gears, now I have also shown you these rotor blades of the fan. These things will what do you call are made with a combination of those materials.

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What it is: The name nylon can be used for any one of a number of synthetic polymers originally created as replacements for silks. Nylon is a tough material that has a very high tensile strength, meaning that it can hold a lot of weight without breaking. It melts at about 250 degrees C and is nontoxic.

Nylon's use as relatively a 3D printing material is relatively new, but the material is becoming popular because the prints it produces are very tough and resistant to damage. It is cheap, because nylon is widely used in other industries, and it's not damaged by most common chemicals. However, nylon does require high temperatures to print: 250 degrees C is hotter than many extruders can manage. And it is harder to get it to stick to the print bed than with ABS or PLA. Generally, nylon requires both a heated print bed and white glue to stick while printing.

Pros: Tough; Inexpensive printing material

Cons: Requires high temperatures to print

Good for: Utensils that touch food, plant pots that fill with water

Cost: $18 per kg

Compatible with: FDM printers that can heat the extruder to 250 degrees C, such as the Ultimaker 3

The true engineering plastic is probably nylon. We have several of the parts which you see actually are probably all made with these things that is strong and they have a way of you know the one you see there is a clip, it is probably a clip to hold something to the other and similarly you know these are some wells, microwells and then I am not able to what do you call identify the parts.

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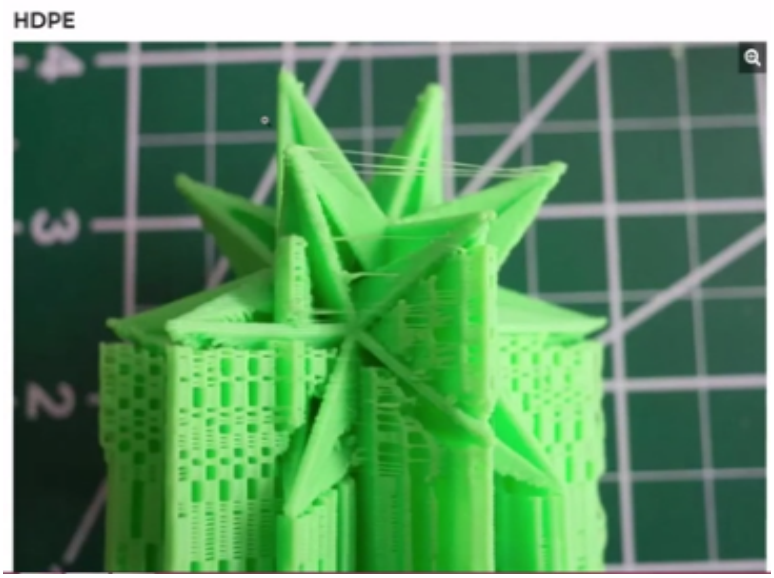

The name can be for any number of synthetic polymers originally as replacement for silk. It is a tough material that has very high tensile strength. It can hold a weight without breaking, melts at about 250 degrees and is nontoxic. It is used a relatively 3D printing material is new, but the material has become popular, prints produce tough resistant to damage. It is cheap, cheap is not a proper semantic word, it is inexpensive. Because nylon is widely used in other industries. Not damaged by most chemicals.

Nylon does require high temperatures, hotter than many extruders and it is harder to get to stick to the print bed with than with ABS. Generally, requires both the heated print bed and white glue to stick while printing. Inexpensive, what they have called cheap there, now he has made it inexpensive here. And utensils that touch food, plant pots that fill with water and all that, these are the things.

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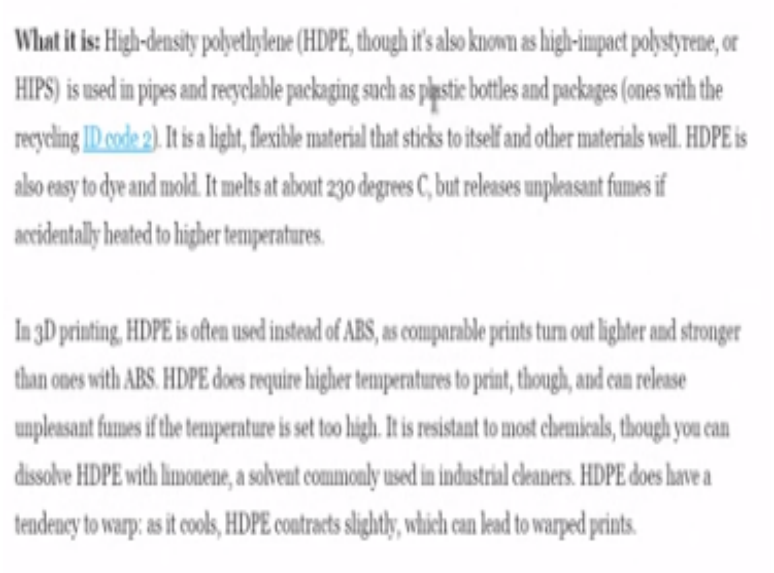

What it is: High-density polyethylene (HDPE, though it's also known as high-impact polystyrene, or HIPS) is used in pipes and recyclable packaging such as plastic bottles and packages (ones with the recycling ID code 2). It is a light, flexible material that sticks to itself and other materials well. HDPE is also easy to dye and mold. It melts at about 230 degrees C, but releases unpleasant fumes if accidentally heated to higher temperatures.

In 3D printing, HDPE is often used instead of ABS, as comparable prints turn out lighter and stronger than ones with ABS. HDPE does require higher temperatures to print, though, and can release unpleasant fumes if the temperature is set too high. It is resistant to most chemicals, though you can dissolve HDPE with limonene, a solvent commonly used in industrial cleaners. HDPE does have a tendency to warp: as it cools, HDPE contracts slightly, which can lead to warped prints.

Next, we come to high density polyethylene. What exactly is HDPE? This is the same plastic bucket, wrongly called high impact polystyrene, but high density polyethylene is used in pipes and recyclable packaging such as plastic bottles and packages and all our buckets come from that. The advantage being that it is widely available and the granules and filaments and all that are very, very easily available.

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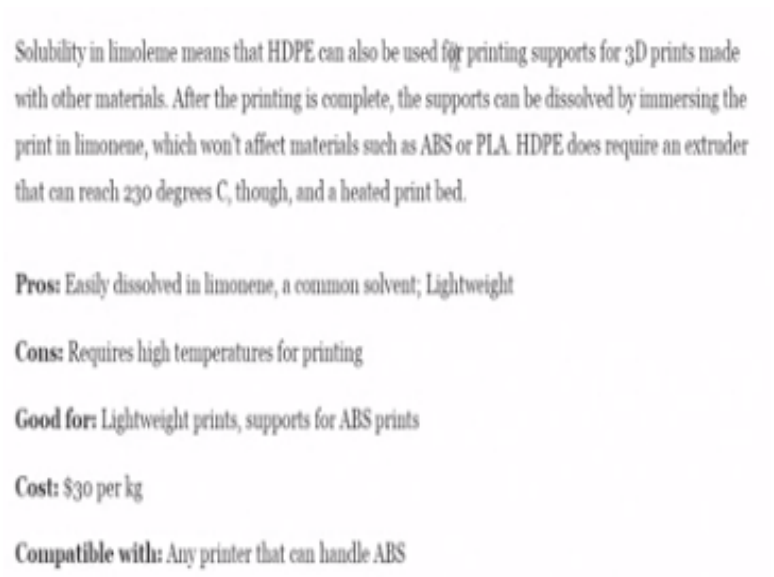

Solubility in limolene means that HDPE can also be used for printing supports for 3D prints made with other materials. After the printing is complete, the supports can be dissolved by immersing the print in limonene, which won't affect materials such as ABS or PLA. HDPE does require an extruder that can reach 230 degrees C, though, and a heated print bed.

Pros: Easily dissolved in limonene, a common solvent; Lightweight

Cons: Requires high temperatures for printing

Good for: Lightweight prints, supports for ABS prints

Cost: $30 per kg

Compatible with: Any printer that can handle ABS

So, slowly know HDPE is getting to be useful in what do you call often used as comparable printers, turn out lighter and stronger than with ABS and HDPE. HDPE does require higher temperatures to print though, and can release unpleasant fumes, the temperature is set to high. It

is resistant to most chemicals, you can dissolve with limonene and so on huge this thing. It can also be used for a support material for 3D prints made with other materials.

Supports can be dissolved by immersing the thing in the appropriate solvent and would not affect materials. So, up to that point what we see there is the usual opaque commonly needed prints.

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You see the next item, see here, PETT, polyethylene terephthalate. What looks like actually a missile or something. It is probably just a model or it is a toy or something like that. It has a very interesting appearance. It is a chemical made up of what do you call trade name T-glase similar to polyester used to make clothes. It melts at about 230 degrees, but cools into a rigid solid that resembles glass.

It can be dyed while still retaining the glass like qualities. It is available in multiple colours. T-glases uproot for food use, so you can use it to make dishes, cups.

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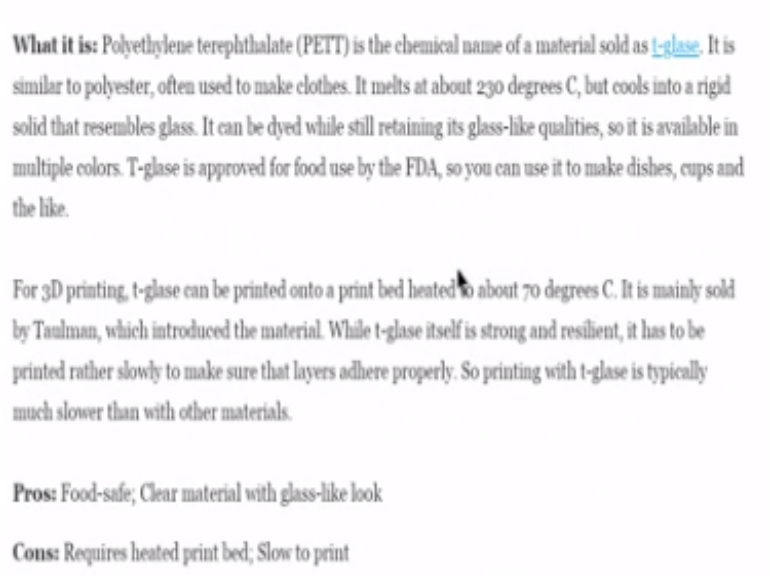

The 3D printing T-glase can be printed onto a print bed heated to about 70 degree centigrade. Why this heating is required is, otherwise things solidify quickly and once they get stuck to the base, it is not easy to remove them, it sort of sets very well. If it is preheated, first of all distortion is not there because it is sudden change of temperature right from 230 degree softening and to room temperature which could be 25 degrees gives a problem.

But, if you keep it above 70 degrees, the printing and distortion is avoided and overall know the one is energy required for the printing and secondly stability of the parts is assured.

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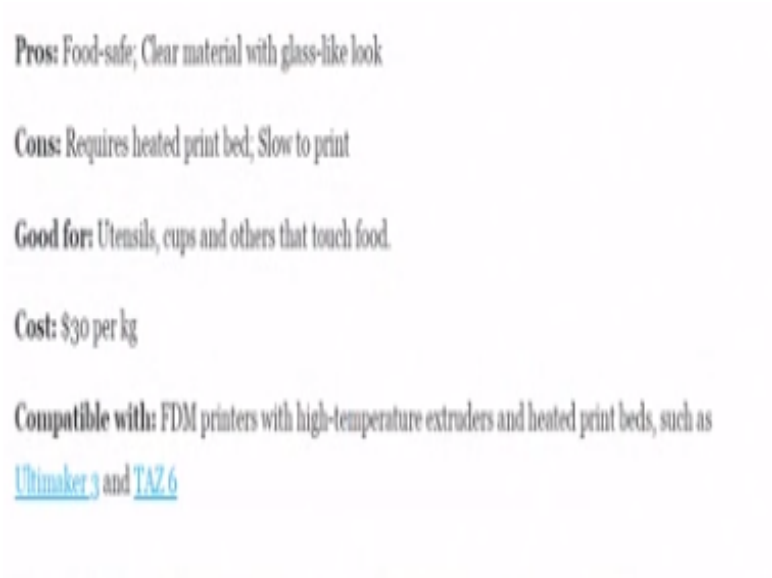

It is mainly sold something a company which introduce the material. T-glase itself is strong and resilient. It has to be printed slowly to make sure layers adhese properly. Printing with typically much slower than other things. Clear material with a glass like look. Requires heated print bed, slow to print, used for things which are there.

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Next we come to so many of the new things. A wood fill filament. I have never seen it myself ok. I have not seen it myself, but I explain that it is a combination of materials. These filaments are not made out of wood, but instead contain very fine wood particles combined with this polylactic acid and a polymer that binds them together and printed and polished the finished material can look like wood.

Versions are available for many different type of wood from bamboo to ebony and mahogany. Some of these filaments allow to change the colour of the printed material by varying the temperature. You see here this looks like a case I think know iPhone case that was 3D printed that you know, it is just a novelty item, but eventually all these things in the long run will probably replace several of things which typically we are used to wood, because it feels warm to the touch. Even plastic has a slightly higher conductivity than wood.

Wood because of this texture and weight it feels warm and we have got used to that what you call anything which has that look know already is acceptable more. In fact, a lot of the outdoor stuff

you see is probably inside there some other material, it could be aluminium, it could be something else and it is covered with a vinyl sticker and it just looks like wood. So, several of these even electronic boxes and all which have a wood covering and best example is consoles for cars.

If you see the console and the fascia a car the dashboard, the cheap ones are just printed with a wood pattern on good old plastic. Making those things out of this is very, very easy. So, if you want to try a new gadget, it could be a what do you call a map maker or it could be I do not know something know which is very, very dangerous texture, anything which you want to do or a GPS tracker or a child alarm or something will be much more acceptable if it matches with the remaining thing or it contrast by showing quality.

In all such special applications invariably this wood items are kept. Now if you go to; these materials are printed in the same way as PLA with similar extruder this thing and so on.

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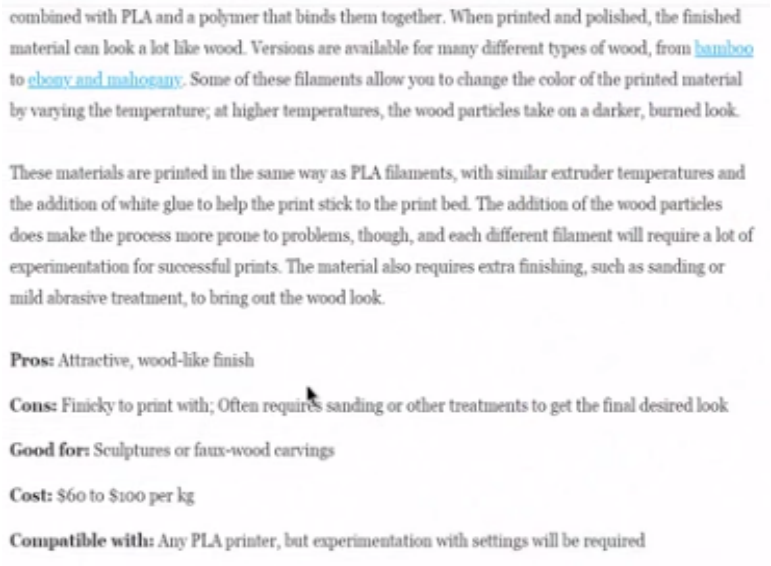

Wood like finish, but only problem is finicky to print with, requires sanding or other treatments to get the final desired look. So, more it is costly, the more it is attractive.

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From here onwards know, honestly I have never seen a metal printed item except by the manufacturer and we have a defense established here. Most of our defense establishments at least the sellers claim, they use the full metal this thing. So, we have something here, you read it yourself at the bottom.

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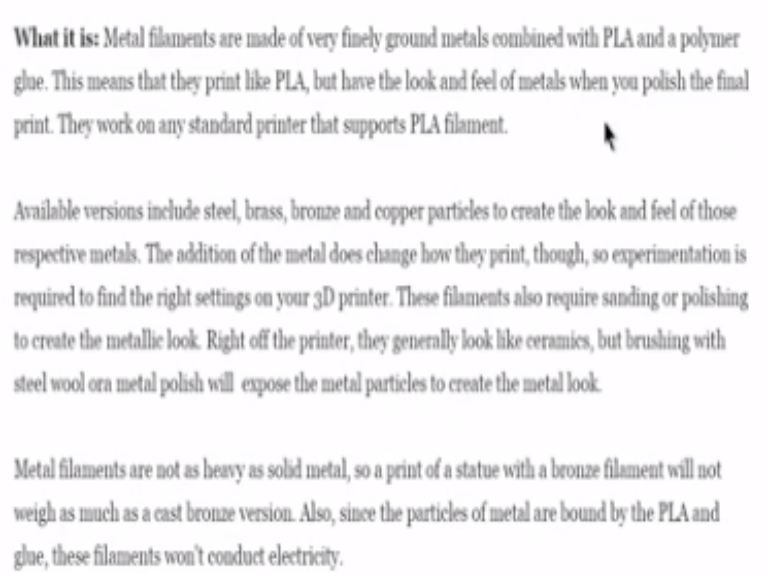

See this only the look is metallic, it looks like gold, it may or may not be there. So, may be you can make a what do you call 19 what 9.999 gold brick. We are just having a core which is probably made out of lead or even mild steel and you insert it inside and for good effect, nobody will believe it. You can at least show it your friends that you are rich. That includes steel, brass, bronze, and copper particles to create the look and feel of them with respective material.

Addition of the metal does change how they print. So experimentation is required. So, this being in the creative and early stages. You need to do I would not call it trial and error you need to you know specifically try your particular design. It is not like routine the usual ABS and PLA materials which are HDPE materials which are routinely supplied by the manufacturers. If you go down further, we have this carbon fiber mix. You see here, this beautiful car detailing.

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Everything here is made with carbon fibers. You see non-electronic parts are printed with carbon fiber. The exact stuff which I showed you the other day know, I showed a small box. The whole box was printed with carbon fiber what do you call plastic. We have an advantage, we wanted a different you know purpose for it saying. It should look as if it is losing heat and say colour, which is actually incidentally does not take anything and we did not want it look like cheap plastic. Look at it, it looks like.

Now you see here, the whole thing know, it is of course assembled, it is not just printed and I do not know may be tyres will come on top of it. Carbon fiber filaments uses nylon of, this one from thing uses PLA, combine carbon fiber in the filament material to give you some of the advantages of this new material, rigidity, strength and low weight. This should be used with caution.

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What it is: Carbon fiber filaments – like this one from MatterHackers that uses nylon, or this one from Proto-pasta that uses PLA– combine carbon fiber and the filament material to give you some of the advantages of this new material: rigidity, strength and very low weight. However, this should be used with caution. Carbon fiber is a very abrasive material that can wear away the hot end of the extruder very quickly, so you'll need to get a reinforced extruder or replace it after a few prints.

There is one company that is making true carbon fiber 3D printers: MarkForged. Its Mark Two, Onyx and Mark X printers can print using the company's own pure carbon fiber filament. But those printers aren't cheap; the Mark Two will cost you a cool $13,499, while the carbon fiber filament it uses costs $149 a reel.

Pros: Has some of the lightweight strength of carbon fiber

Cons: Can damage some extruders; Expensive

Good for: Structural prints that need to be strong and lightweight.

Carbon fiber is a very abrasive material that can wear away the hot end of the extruder. You need to get a reinforced extruder or keep replacing.

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We have this know so many of these printers which use it expensive, but useful. Now we come to the much more interesting and other thing saying. So far we have been talking about materials which are intended to be rigid, just the material just are intended to be rigid are they are actually rigid and when you want to make something flexible as in an elastic band, it could be a hair scrunch or it could be in this case know something like, sir can you show me this.

I am sure several of you probably have variance of this activity trackers and you can easily print any of these things using any plastic, but if you want a type of flexibility, of course this one is a mesh, it is a pakka stainless steel mesh. It has been oven and it has all the novelty, but if you see at one end part you see here has a strict small detailing, there is a grew, there is a magnet inside, there is a gasket all around like that, it goes and sticks here.

Parts like this know require a little bit of on one side rigidity and one side flexibility. So, in this case it is made out of magnet support material and then a rubber. These things can probably be easily replaced by flexible material that is shown here. If you just read it along, while all 3D printing material strive for rigidity creating prints that are strong. That is not always what you need.

Flexible filaments like all these flex, produce rubber like prints that can use to make things like phone covers, flexible joints, and wearable prints. So, I am sure lot of you have seen this and lot of gag prints are there. So, there is one print I have seen which is my favorite at the back. It looks like an old Rolleicord camera ok. If you holding it, people will think it is a Rolleicord camera.

And it has even etching things on it. You know it looks like there is actually a lens here and all that and then my son, he looks up and he will make it think come on look and then he clicks it and you have what do you call a cover, which looks exactly like a Rolleicord camera and then you have it with everything else. I will just try, just I mean, kindly just be, I mean a little patient, and I will see whether I can get it.

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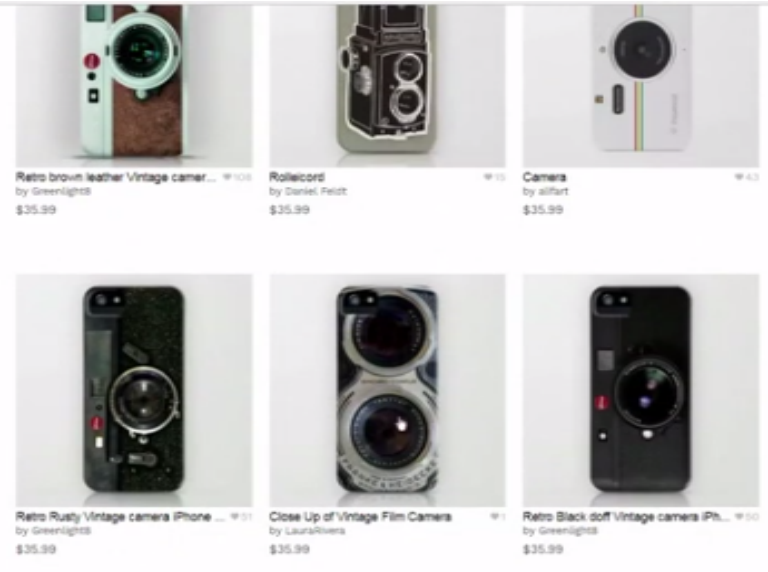

These are all retro brown leather vintage camera case seen that know. There is not a print like this. This one is a Rolleicord print. This is, it is just a cover which is printed to make look like something and then. Frank and you know high décor lenses know. The whole thing is printed on a 3D printer and you can just push it on your camera and then your camera know your normal android camera looks as if it is a full-fledged old vintage camera and these things can easily be printed using the material which I was showing you that is flexible material.

And if you can now combine it with other things including a lens, may be a real lens, you can get the lens from a VR kit. So, you VR kit you have the lenses, may be if you make a grove and fit the lenses and all inside, you will have something which actually looks like a beautiful old Zeiss or the other Schneider lenses, which will be a beauty, absolutely beauty for you. This is where the flexible materials make a lot of impact.

And you see that if you make something hard, it does not necessarily protect your thing inside. Optimum amount of crushing and resistance should be there. This resistance and optimum amount will absorb the shock. So, things which have corners and all that are best printed using all this.

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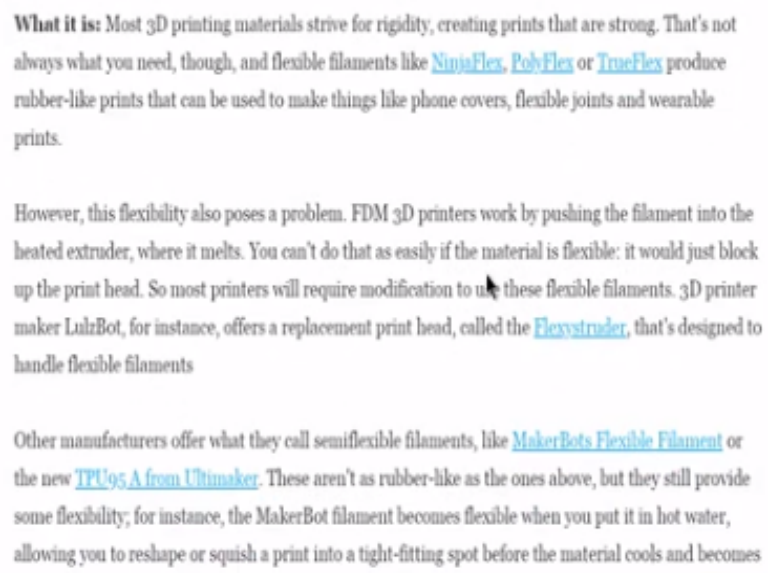

What it is: Most 3D printing materials strive for rigidity, creating prints that are strong. That's not always what you need, though, and flexible filaments like NinjaFlex, PolyFlex or TrueFlex produce rubber-like prints that can be used to make things like phone covers, flexible joints and wearable prints.

However, this flexibility also poses a problem. FDM 3D printers work by pushing the filament into the heated extruder, where it melts. You can't do that as easily if the material is flexible: it would just block up the print head. So most printers will require modification to use these flexible filaments. 3D printer maker LulzBot, for instance, offers a replacement print head, called the Flexystruder, that's designed to handle flexible filaments

Other manufacturers offer what they call semiflexible filaments, like MakerBots Flexible Filament or the new TPU95 A from Ultimaker. These aren't as rubber-like as the ones above, but they still provide some flexibility; for instance, the MakerBot filament becomes flexible when you put it in hot water, allowing you to reshape or squish a print into a tight-fitting spot before the material cools and becomes

Here, phone covers I showed you, flexible joints and wearable prints. These flexibilities also possess small problem. FTM printers work by pushing the filament into the heated extruder where it melts. You cannot do that as easily if the material is flexible, it would just block up the print head. So most printers will require a modification to use these flexible filaments. 3D printer makers like so on and so on know offer a replacement print head called the flexiextruder that is designed to this thing.

Other manufactures call semi flexible filaments like MakerBots flexible lens so on and all that. These are not rubber like as the ones, but still provide some flexibility. For instance, becomes flexible when you put it in hot water, allowing you to reshape squish print into a tight fitting spot before the material cools and becomes rigid again.

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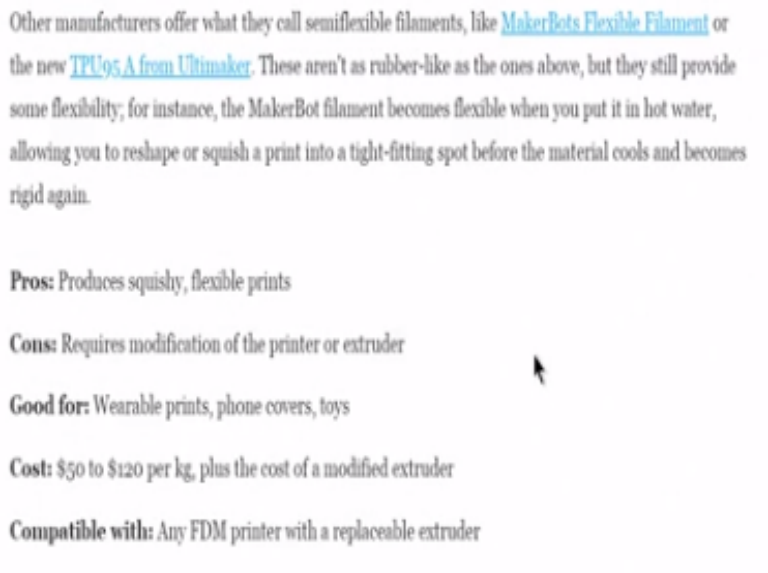

Now, you have, you see the other things, there are not that easy they are not as easy to print as you would print this thing and as they make you believe in the popular press that you can print anything at home. You print a gun at home and I would not know whom you would like to shoot, shoot the shooter. We are not violent people know, but we would like to defend ourselves like that.

In case somebody is ready to shoot, at least you know incapacitate them and prevent them. But, the reality is not that easy.

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Now we have come to which is something which is my favorite saying, can we make conductive filaments. This in our electronics, we have an advantage and a disadvantage also. One of them is we need connections. We need both conduction and we need insulation and conduction you will be surprised even if you take most of our LCD prints and all that know, it is a transparent material glass or something and there are conductors printed on it.

If you print a very fine I do not know gold or some other materials thin enough and make it into matrix the eye cannot detect, but that can be used to apply a voltage. It cannot take a current, but a voltage can be applied. Now these, these conductive filaments they have modified some of the properties. If you see my presentation, you will see there, please show this sir.

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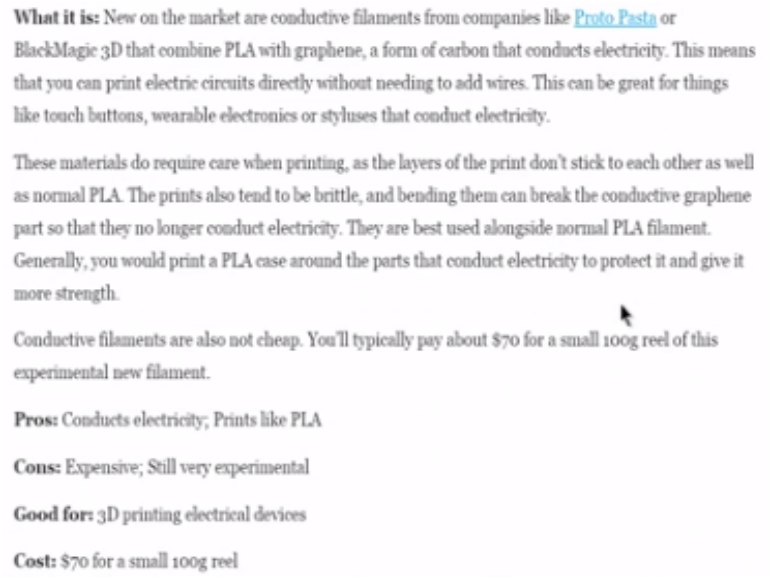

Black magic 3D that combine PLA with graphene, a form of carbon that conducts electricity. This means that you can print electric circuits directly without needing to add wires. This can be great for things like touch buttons, wearable electronics, or styluses that conduct electricity. These materials also require care when printing, as the layers of the print do not stick to each other as well as normal PLA. The prints tend to be brittle and bending them can break the conductive graphene so that they no longer conduct electricity.

These are best used alongside normal PLA filament and you would print a PLA case around the parts that conduct electricity to protect and give it more strength. So, in principle, whole printed wiring board can probably be made as part of the product what you require.

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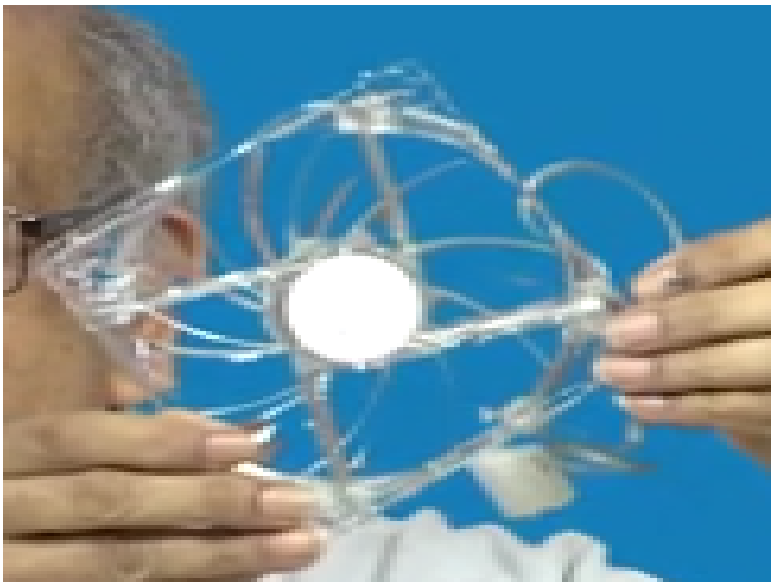

So, if you see, I have this fan. Everything is fine, except inside this ribbon cable I still have copper, as copper is a must. Because something of the order of nearly 1 amp has to pass through this. Imagine and to support this again we end up with this, three of the supports are normal and one of the support is wider than the other, so lot of circus is required for doing it.

Imagine one day if we were to make this out of conductive filament, we can probably use we have four supports know, two of the supports can probably have a what do you call one polarity, two of the other supports can have other polarity and I will not have this wire sticking there. I can probably plug in the whole fan having + and a – here and a + and a – here. If I plug it in appropriately, nicely the fan will work and look mum, no wires. I will be able to work well without wires.

Eventually, I may have you know fully conductive materials like this by which life will be easy. But right now it is not at this stage. Right now, it does know, these parts require little bit of physical structure continued to be in this and the outside thing can be made flexible, but still there a copper inside. Eventually, when only simple voltage driven with very little current as

required as in this case typically, we will eventually probably go for those things which is I feel very good thing.

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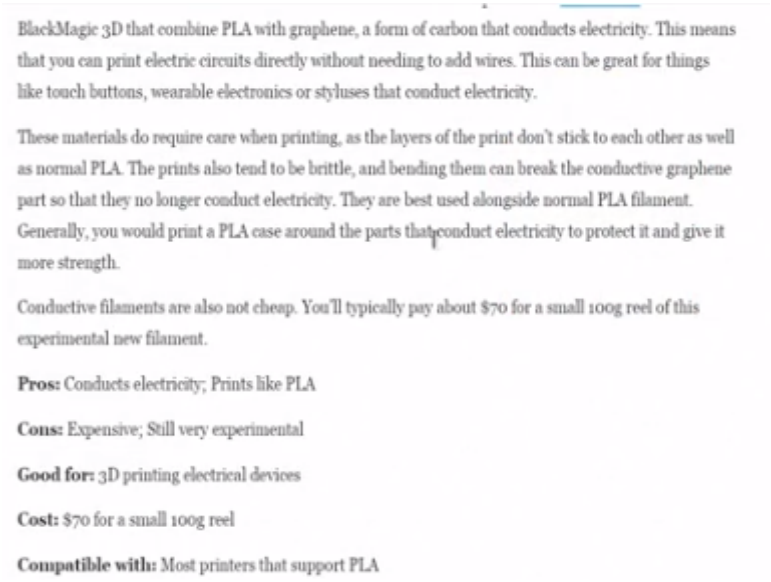

Now if you kindly look at this again, they are best used so on and the parts that conduct electricity protected and give it more strength. So, we have come almost to the end of it. Now, if you go to several what do you call websites you have various advantages, disadvantages of all these materials. This particular thing gives you what all that has given ok saying.

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We have polyamide nylon, white, strong and flexible. Strong and flexible plastic, so he has given examples here seen here again. Once again, we have a beautiful case, mobile phone case and

then I know we have a printer thing. Then, he has given all the properties minimum wall thickness, details and structures and the price, so if we go everywhere know.

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Next we have ABS, normal home printers. They come with these things see here. Details and texture are poor, price is okay and then 1 mm and then it is strong and flexible. So, anything you would like to print probably you will use these things.

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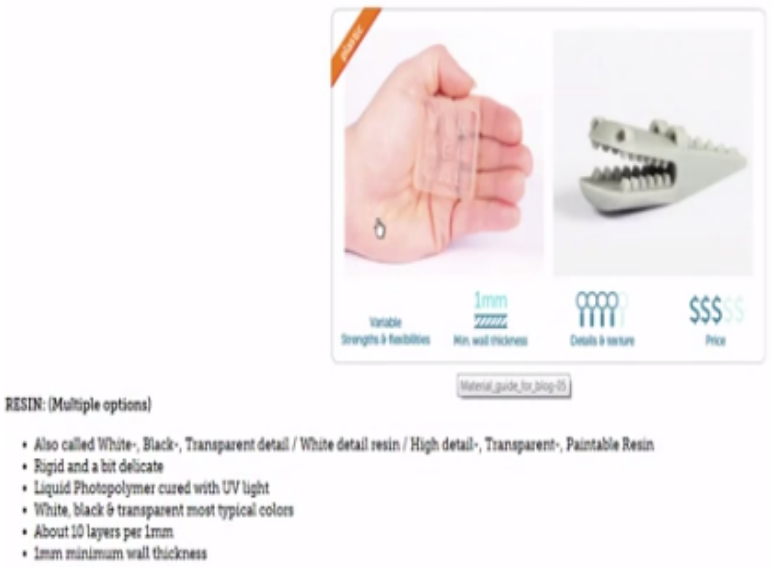

Next, we come to the word resin is used. I am not clear what exactly he is talking about. Transparent, white detail resin, high detail, printable resin, rigid and bit delicate. So, resin is generally used to what do you call describe anything which does not have a sharp cutoff point

unlike metals or even all other liquids of ice and all that know, ice exactly melts at 0 and if you take any metal they all at a defined temperature, 800 degrees, few degrees below its metal, few degrees above it will become into pouring consistency.

Unlike that the resin has wide this thing. At about it starts softening around may be 130-140 degrees and it does not melt at all. That from 140 to around 200-250 degrees, still it will become sticky and stringy and so on, little like some of our food materials we see. So, calling it resin, I am not very what do you call comfortable with it, because all plastics are resinous plastics only.