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3D printing guides: Everything about heated beds!

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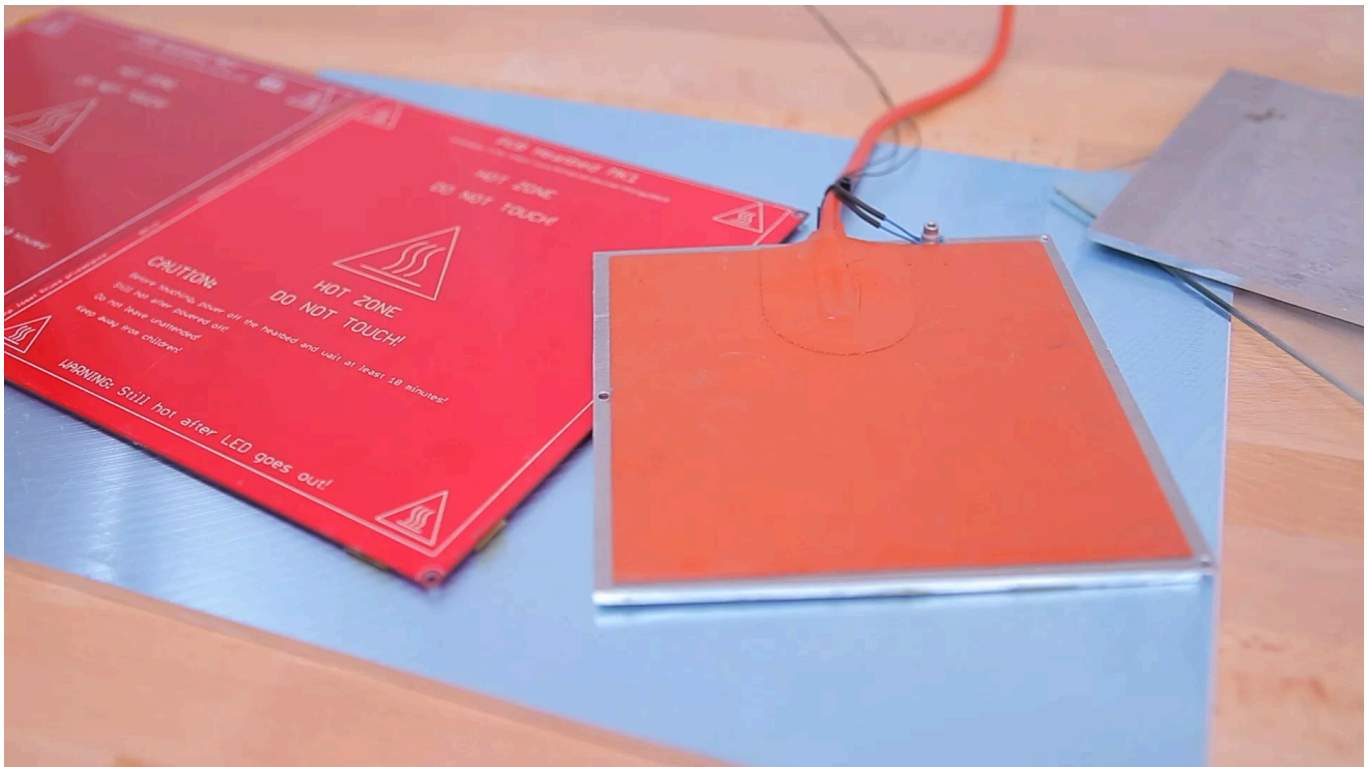


Planning on getting a heated bed for your 3D printer? Awesome! These are the things you should know about them.

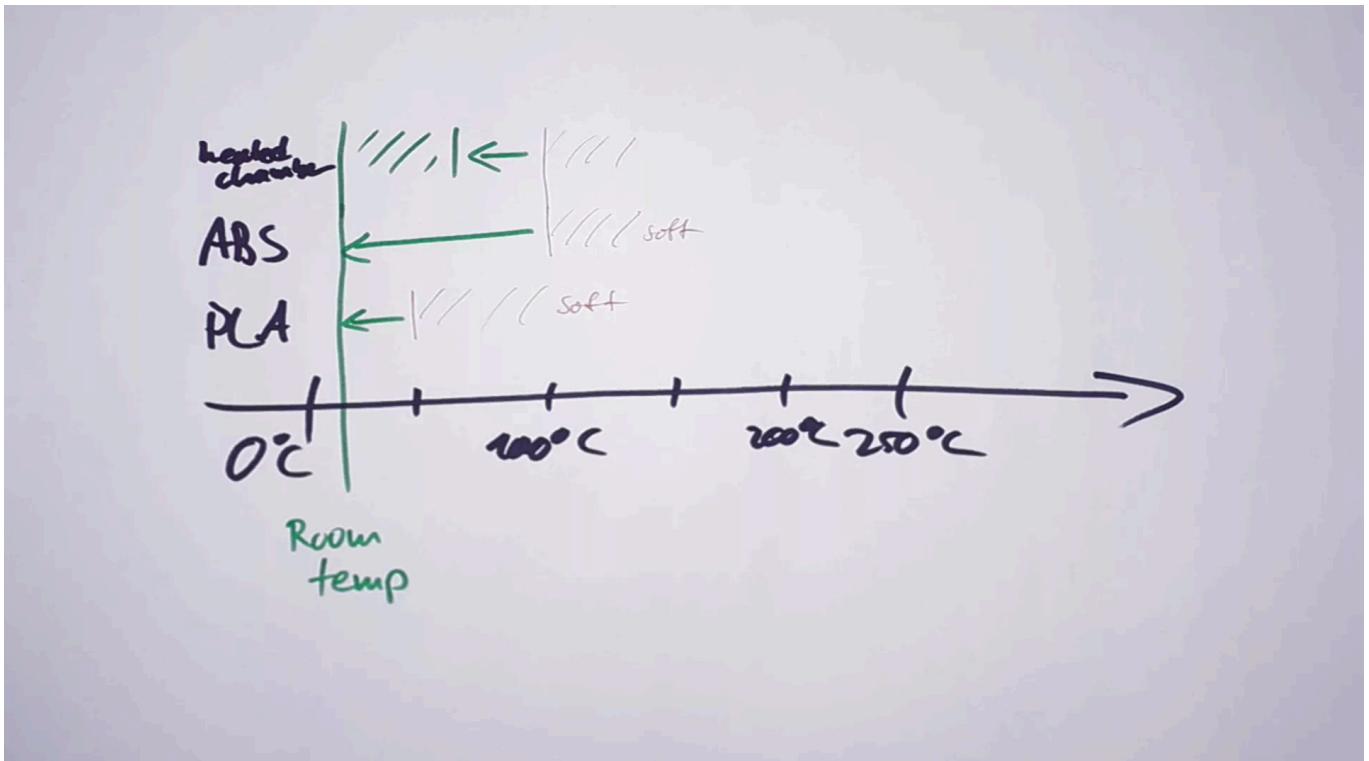
Hi everyone, i'm Tom, and two days ago, i wrecked my voice. I'll try my best to be comprehensible today, but, as always, if you're having trouble understanding my spoken words, feel free to turn on subtitles, those usually have the full script i use / in there and should be pretty accurate.



But anyways, today's topic is going to be heated beds, that has been one of the most requested topics, so today i'm gonna tell you all about them!



So, heated beds have one very obvious main purpose: And that is to get the surface of the print bed up to a temperature where the print will stick to it better and, as such, will not come loose from the unavoidable warping forces that the layer-by-layer printing process generates. But a heated bed has a second side effect that can help reduce warping at the source, and that's because the radiated heat will help keep the print warm. You see, that largest factor in how much a print is going to warp is, roughly speaking, the difference between the plastic's glass transition temperature and the "cooled down" temperature during a print. So either, you have PLA with a low glass transition temperature of 50°C and let it cool down to 20° with an unheated bed, or you use ABS with a glass transition temperature of about 100°C and just make sure it doesn't cool down as far. The extreme case of this would be a heated chamber, which keeps your ABS print at 60 to 80°C, so you'd end up with the same 30° temperature difference. Heated chambers or at least enclosed printers are extremely nice for the high-temp plastics, but that's an [entirely different topic](#).



Now, because of those two effects, i still haven't found a plastic that is not easier to print with a heated bed. I mean, sure, you can print PLA on blue tape and some of the soft plastics onto glass and such at room temperature, but even for PLA, having the option of heating the bed surface

and printing straight to glass is just so much more convenient than having to pry your prints from blue tape. Of course, heated beds are absolutely necessary for some plastics, like ABS, which can be printed onto a cold surface, but that involves a whole new level of kludges.



As far as the heated beds themselves go, there are two basic types that you can get. One is the classic PCB heater, originally designed by Joseph Prusa, which was the first heated bed that you could buy. Along with the Prusa Mendel, it basically established the mid-size form factor of a 200 by 200mm build platform. You can still get heater PCBs that are very close to the original design, some of them can now be switched from 12V to 24V, others have different form factors, like the round beds intended for Delta printers. But there's two issues I personally have with heater PCBs, and those are, one, it can be pretty hard to get them to make good contact with whatever sheet material you put on them, which becomes necessary, because, two, they have a tendency to warp and bulge, especially the cheaper and thinner ones. As the controller applies power to the bed, the side with the heating tracks heats up much faster than the opposite side, the PCB expands on the hotter side, and in the process of that, bows the entire print surface. In fact, one of my first big mysteries with my back then Prusa i2, was that the second layer just wouldn't stick onto the first one. And as it turned out, because I was reducing the heated bed temperature for all layers but the first one, the heated bed would shut off for a while until it reached that cooler temperature, and, you guessed it, bowed away from the nozzle and basically left a huge gap between the first and second layer.

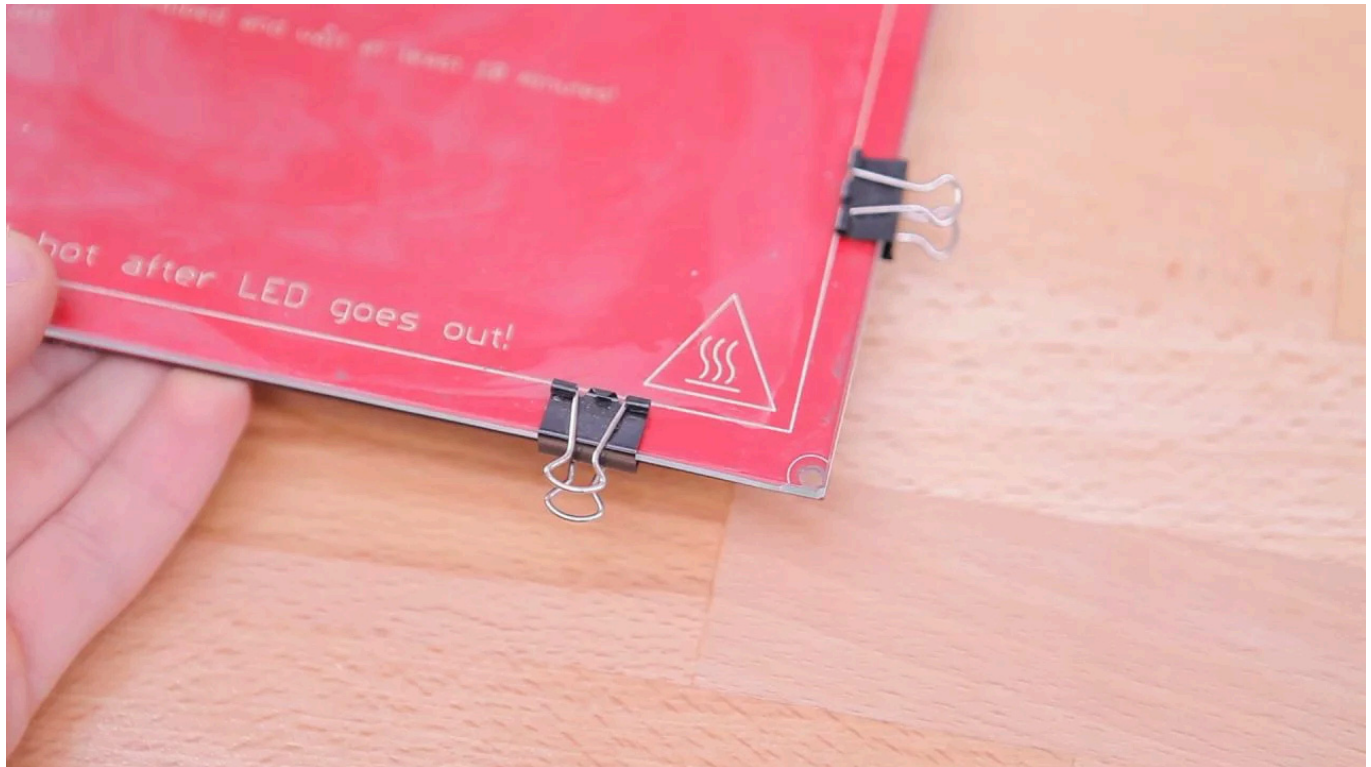
So, the other option, which I like a lot more, are heater mats that you can stick onto the bottom of your print sheet, in my case, aluminum because I also use an inductive probe for bed auto-adjustment. You can get these heaters from a few resellers in Europe or the Americas, but you can also get them directly from the guys that make them, at any size, voltage and power rating. For example, I had this one made as a 150mm square with 150W, which will take it up to 150°C. More than enough / even for printing polycarbonate. I also have a 300mm round bed incoming that is made to run at 230V mains power, since shoving 600W through a power supply is kinda pointless, and it's pretty hard to wire everything properly at those currents anyways. But, please, if you are using mains power anywhere, be careful, make sure everything is unplugged before you start working on the wiring and ground your printer frame through the protective earth rail.

I've heard from a couple folks that the silicone heater mats tend to give up after a while, but I haven't had any problem with mine so far. And I've been torturing it quite a bit.

If you're wondering what kind of power you need for a certain size, it's relatively simple: you need at least about 0.6W for every square centimeter of heated area to get to 120 degrees for ABS

	150 x 150	200 x 200	Ø 300
0,2 $\frac{W}{cm^2}$	45 W	80 W	140 W
0,6 $\frac{W}{cm^2}$	135 W	240 W	420 W
1 $\frac{W}{cm^2}$	225 W	400 W	700 W
	Prusa PCB 150 W $\sim 0,4 \frac{W}{cm^2}$		

or about 0.2W to get to about 60 degrees for PLA, but if you want save some time during heat up, you can also go up to 1W per square centimeter. Just make sure your electronics can handle it. Most electronics are limited to 10 or 15 amps of output current, which means that they can just about power a Prusa PCB heater at 12V or something a bit more powerful at 24V. Read the specs for your board and make sure none of the transistors or connectors burn up when you're heating it up for the first time.



Now, as far as sheet material for heated beds goes, again, there are main two choices. You can either use glass and clip that to a heater PCB, or use aluminum in the same fashion or directly stick a heater mat to it. I prefer aluminum, it's cheap, it won't break, ever, it will distribute the heat from the heated bed extremely evenly and it will ensure that the surface temperature is exactly what you want it to be. And you can directly use it with an inductive sensor. For smaller beds, flatness doesn't matter as much, but for larger ones, you can get milled, planed aluminum sheets at almost any size and thickness – this guy for example will end up on top of that aforementioned 300mm heater mat in the

CerbrisReborn. Which i hope I'll get to build over Christmas, but it looks like the ball ends for it aren't going to arrive on time. Anyways, the other material you can use is glass sheet, and that is pretty much always perfectly flat due to the way it's made. Many people use borosilicate glass, which is similar to Pyrex and made to resist temperature shocks, but i've found that regular 3mm window glass works just as well. Even when I heated up one side of my double heated bed to 120 degrees and left the other side cold, it never flinched. 2mm is too thin and has a huge risk of breaking just from the force it sometimes takes to pry a print off.

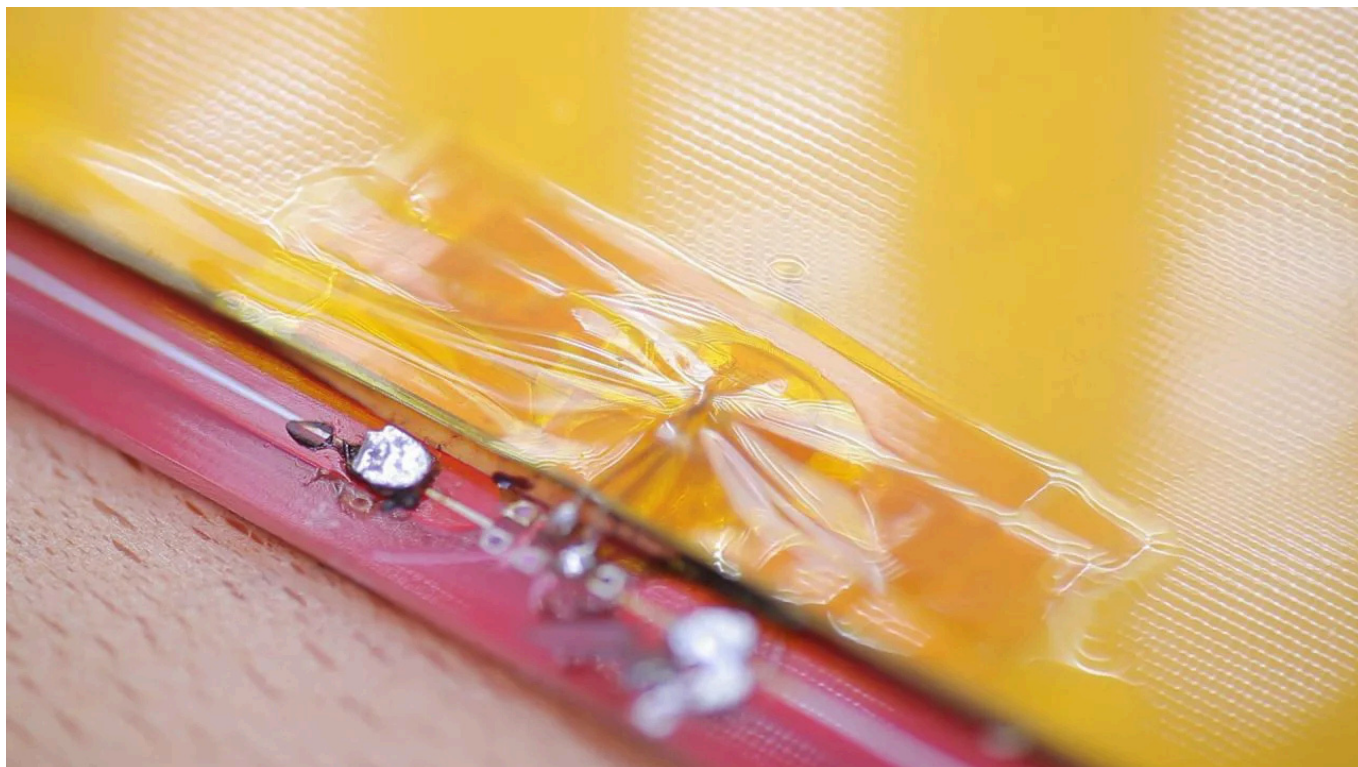


Also, if you're planning on using a heater mat instead of a PCB, I'd definitely recommend aluminum. The heater mats are hand made and can be a bit irregular in their heat output, which aluminum helps smooth out, but also, if you stuck it to a glass sheet and break that, well, you can probably trash the heater, too.

On top of whatever sheet material you may choose to use, you can use different toppings as well. But for many plastics, you don't have to. Many users print directly onto clean, and this is important, absolutely clean glass, many plastics will directly stick to that. Then there's Kapton and PET tape, which are nice for ABS and other higher-temp materials. And there is the glue section of glue stick, diluted PVA glue and hairspray, each of those having their own unique properties, and, as always what might work for everybody else might just not work for you. So there's definitely some trial and error involved, but there's always some way that works out. Most of the surface choices lose their stickiness when they cool down, so prints are going to be much easier to remove or pop right off if you wait for the bed to cool down after a print has finished.



One last thing i want to talk about is thermistors in heated beds or # for heated beds. Because they are always somewhat awkward to place if you want a good reading. If you tape one to the bottom of the heated bed, the top might end up being much cooler than the spot you're actually measuring, if you put it on top of the heated bed, you obviously have the risk of running into it with your printer's nozzle. Either way, you should really make sure that it is well-insulated from the air around it and gets good contact to the spot you're trying to measure. Some newer PCBs have a spot in the center to place a thermistor, which is actually a really decent place to put it. The silicone heaters, on the other hand, can be configured with a thermistor built-in, but i've found that it reports temperatures that are way too low. Either way, if you have a thermistor in a spot that isn't exactly where you need the temperature, i'd at least recommend waiting a bit after heatup before you start the print, that way the heat has some time to soak through the entire construction you have on there. Or, if you have an aluminum bed, you can also use the E3D v6 method and clamp a thermistor into the aluminum plate, that way, you'll get exactly the temperature the bed actually is at.



So, i guess that's got to do it for today, if you have any questions left, please feel free to leave a comment and i'll try to answer those. I'll see you next week, until then, i wish you all a politically correct happy holidays – i don't care much about what you do or don't do over christmas, but

everybody gets a few day off, and that's gotta be worth something. Au revoir!

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