Electronic Systems for Cancer Diagnosis
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Lecture – 46
3D Fabrication Techniques

Hi, welcome to this module. In the last module, what we have seen? We have seen how we can use different materials for 3D printing we talked about plastics; we talk about metals right and we see the advantage of each material and where you can use and you should use that material according to the particular application. For example, in the biocompatible material, what kind of material you have to use you have to use titanium right.

If you are talking about high temperature materials; if it is metal you can use nickel alloy so, from Y am hoping that from that earlier lecture you are able to understand what materials you can use for 3D printing. In this particular module, let us see what are the techniques involved in fabricating 3D components ok. So, we will it is a short module, but it is very interesting according to what I understand; so, that you will understand in detail how different techniques can be used to print the different materials using 3D printer.

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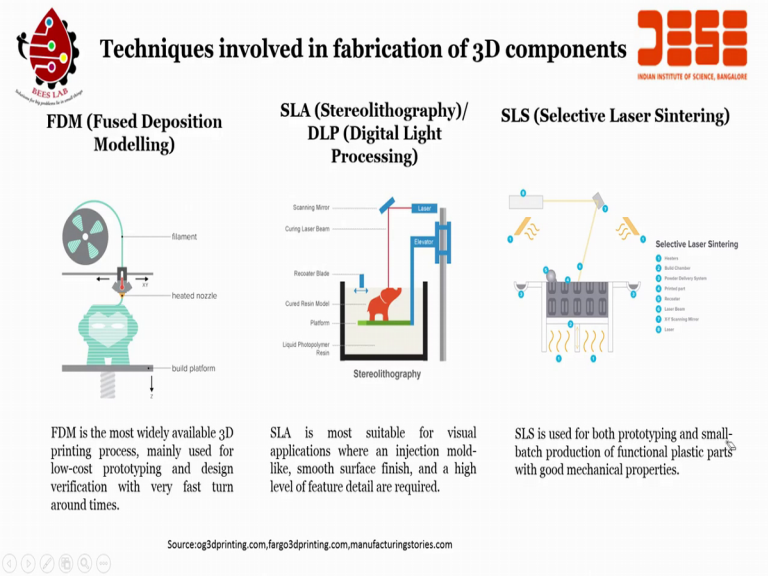

So, if you see the slide what you see here is there are different techniques first one is FDM, then SLA and finally, SLS. We will go one by one. The first one, but we talk about fused deposition modeling, you can see that there is a filament there is a heated nozzle and then there is a building platform right. This building platform can move in Z direction up and down and this filament will move in X and, X and Y directions. So, you can see here this heated nozzle the filament remains a stable I am talking about the heated nozzle.

Heated nozzle, we will move in X and Y direction and the through this filament the material is fed to the heated nozzle and then it will be printed on the building platform. Whenever you require a certain height, then this is a building platform can move in Z direction. Now this FTM which is fused deposition modeling is most widely available 3D printing process mainly used for low cost prototyping and design verification with very fast turnaround times.

We will see such a FDM based 3D printing process as a part of your experiment class where you will be taught how we can use the 3D printing material, how you can print a block, how can you print a block from a remote place lot of things. We will see in the experiment class. If you go to the next one which is your SLA which sends for stereo lithography or you can say DLP which is Digital Light Processing. In this particular process you have the liquid photo polymer resin which is here and then you have a platform then, they were cured. This is the this elephant kind of things that you see here is a cured resin model. You have a recorder blade and then from the stagings, you have a laser elevator scanning mirror and curing laser beam.

So, together using everything what we can do? We can use the system for the complete for designing the complete setup or printing the complete setup and the advantage of SLA is that it is more suitable for visual applications where an injection mold like smooth surface finish and a high level of feature details are required. So, when you want to have a extremely smooth finish and the it should look like a injection molded part, SLA is better over FDM. But if you could talk about SLS which is selective laser printing here the there are several components again including there is a heater, there is a build chamber like this is a build chamber here is a build chamber right and these are the heater.

So, it is a one is a heater here also there is a heater here also there is a heater right and then you have a powder delivery system which is right over here right. Then you have a printed part which is right over here and then your re coder which is this guy you have a laser beam right this one, you have a XY, scanning mirror seven and you have a laser which is number A. So it is a complex system, but the SLS is used for both prototyping and small batch production of functional plastic paths with good mechanical properties. Now, these are another technique used for printing different components.

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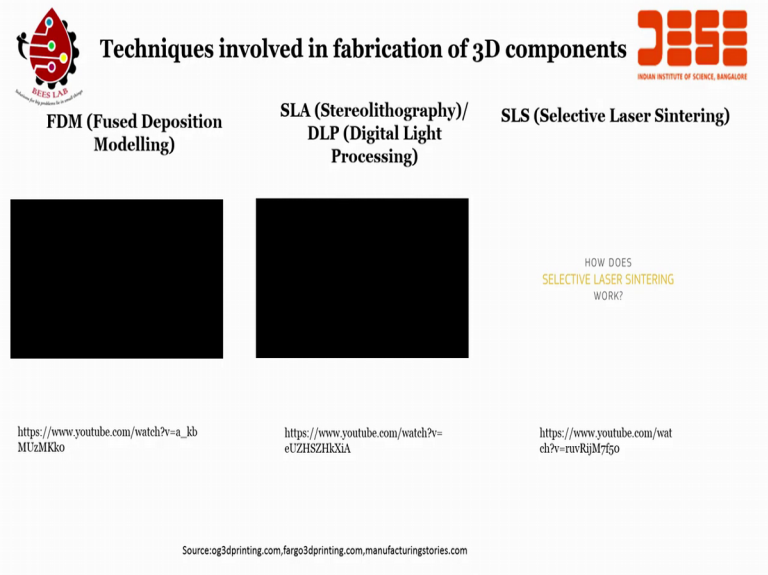

So, let us see these three videos and then you will understand in detail how FDM is different than SLA is different and SLS. So, let me play the first video about FDM and then subsequent videos I will play.

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So, first video an FDM in a world, it is a game changer. It can create parts and geometries that you can do in an injection molding.

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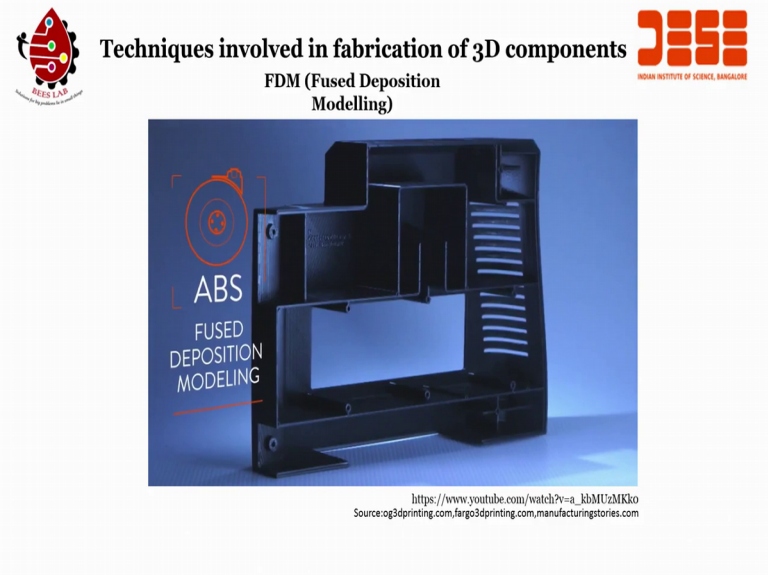

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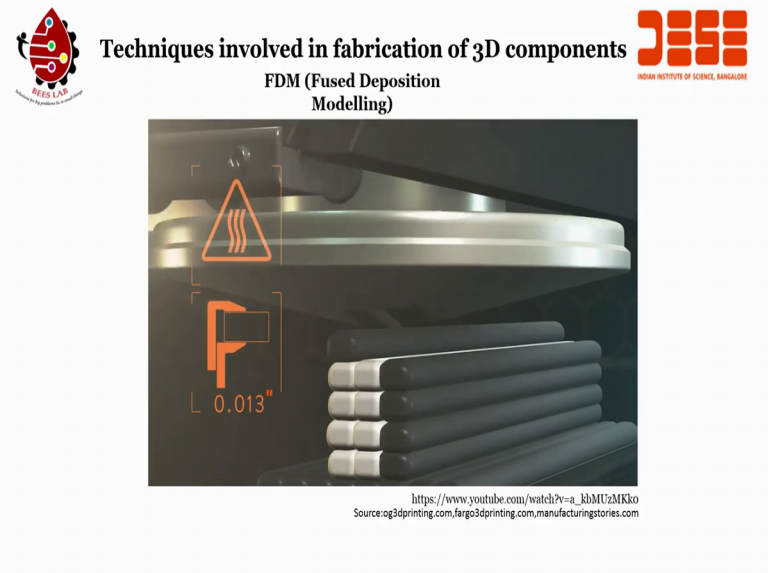

That is going to create a revolution in the near future and this technology be adopted as a major process for manufacturing economy. So, FDM stands for Fused Deposition Modeling.

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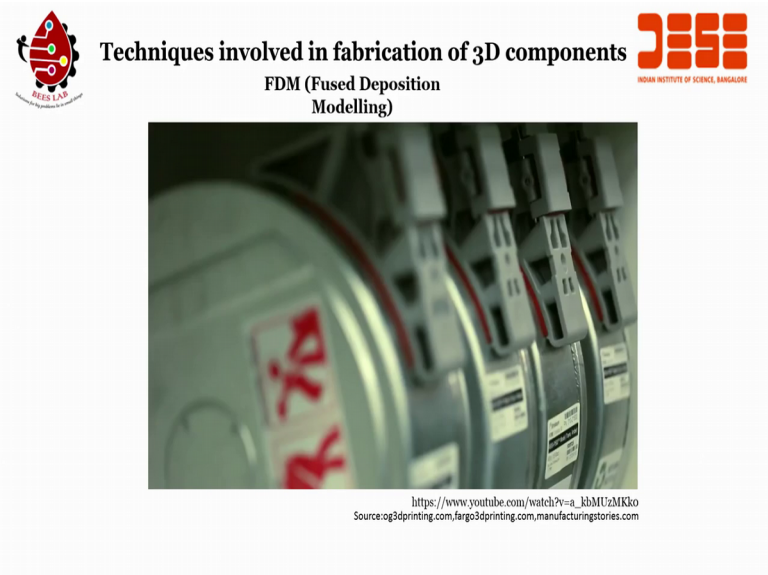

It is a fancy word for laying down a small bead of plastic what is really cool is you can have a real engineering grade thermal plastic. So, the same stuff you would injection mold. Someone needs a ABS or polycarbonate or a high temperature ultem. We can

actually print it directly as opposed To casting a partner into having a ejected molded parts done.

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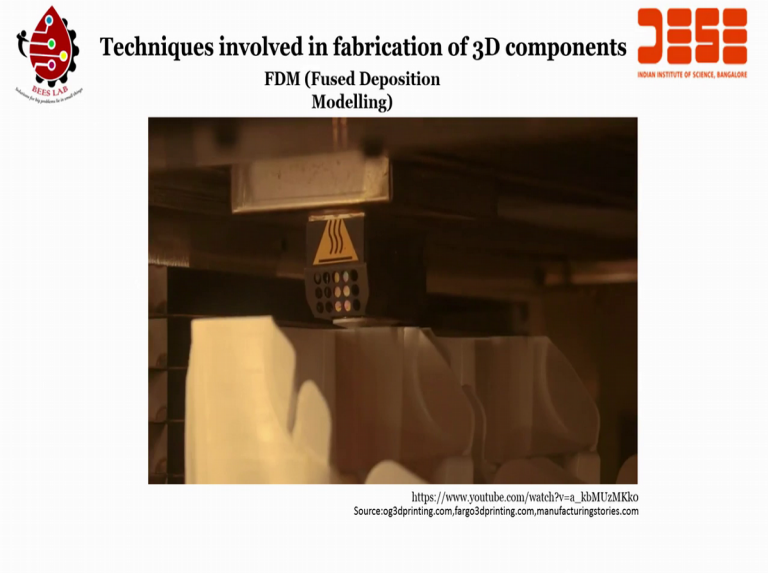

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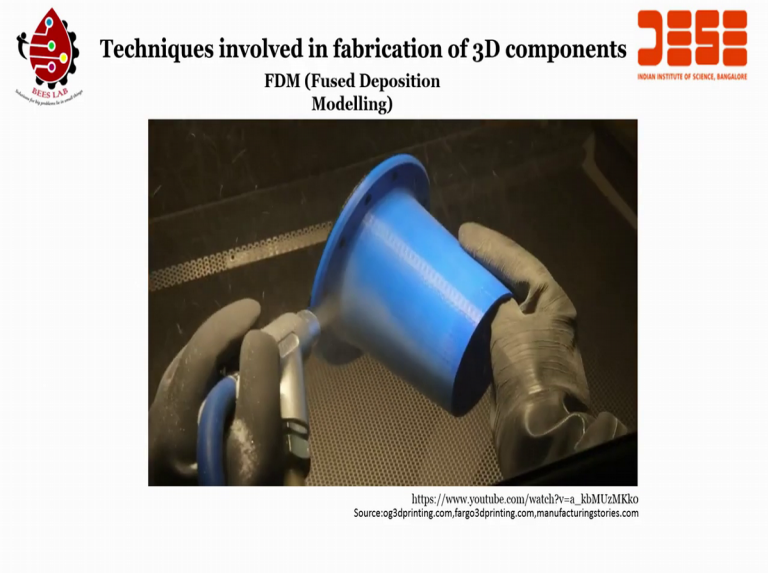

You are getting close to the same quality and in mechanical properties and aesthetics as you would an injection molded part, but you are getting it in an additive process.

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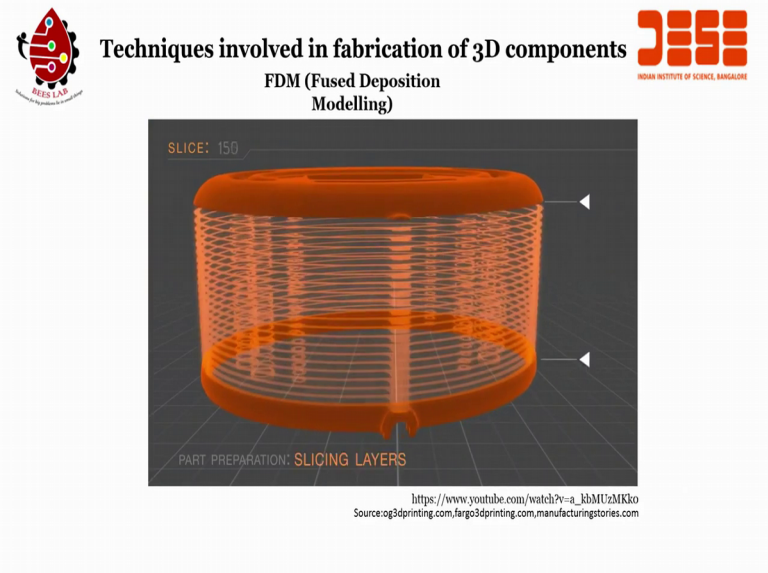

Our software it takes a 3D data file and it slices it into the layers, then creates a tool path that is sent to the machine.

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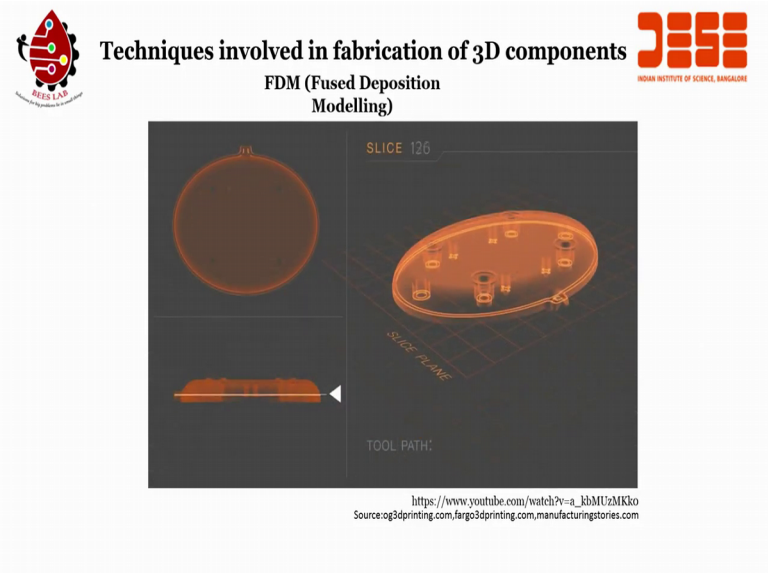

The raw material is produced into a filament like fishing line type one that filament is wrapped around a spool. So, that is your cartridge of raw material that is going to be used to build parts. That material then gets fed up through the machine all the way to the head where it is liquefied and extruded in fine layers. The support material is extruded at the

same time and then layer by layer the part is growing. When the part is completed then its removed from the build platform and then the support material is removed.

We also offer pulse finishing operations that can smooth out those layers. So, whether it is a hand finishing or cosmetic paint we still can provide smooth looking parts. We developed the technology to fit a full breadth of geometry sets. We have seen it use anywhere from small prototypes for mock ups and test fitting parts to really large you know structural pieces like a on airplanes UAVs. We gone from that we are just doing real easy concept models, you know 1 z 2 zs to now we are doing production runs of 5000, 10000 parks that are its the actual part coming from the afghan technology.

So, with it we can do things that I have yet to even think of, but the younger generation they are going to take this FDM process and turn it into something that is its going blow me away from me. Now since you have seen this video; let me also play the second one which is the SLA printing.

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So, you understood the difference between SLA and FDM right. Now also let us see how the SLS printing is different than SLA or FDM; let me play the video for SLS printing as well.

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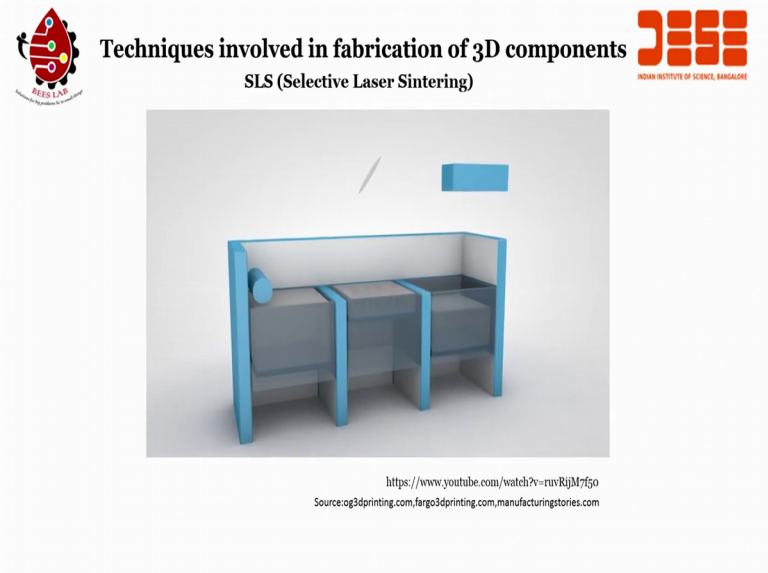

Once the nylon powder is loaded in the supply container and digital instructions, are programmed the laser unit directs a high powered beam to a reflective mirror. From there the galvo motor system steers the focused beam to the powder surface, each layer of part geometry is then sintered into a heated bed of nylon. Pistons move the supply container up and the build chamber down while the roller moves across the bed to distribute the next layer of powder.

Excess powder is captured in a collection container. The process is repeated layer by layer until the build is complete. The quality 3D printed parts get an instant quote today at proto labs.

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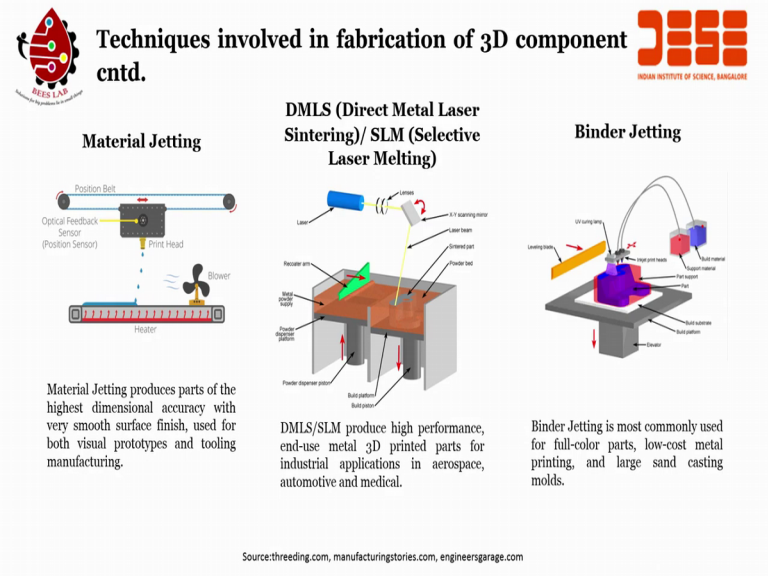

So, you have seen right that there are different techniques to fabricate that that can be used for fabricating several shapes using 3D printer. Let us see few more. We have a material jetting, we have a DMLs and we have a binder jetting. So, in the material jetting process, the material jetting process produces part of highest dimension accuracy with very smooth surface finish used for both visual prototypes and tool manufacturing. Here you have a positional belt your optical feedback sensor which is a position sensor your printed head and then you have a blower.

So, the printer head will move in X and Y direction. There is a heater which is about the bed and it will start printing the material by jetting it over the heater bed or heated bed. While you compare DMLs which is direct metal laser sintering or you can say SLM which is selective laser melting. In this particular process, the material is melted with the help of a laser source and the center part is the powder bed is right over here right and the there is a recorder with a metal powder supply is on one side and the power dispenser system is also on the on the left side of this particular schematic.

The advantage of DMLs or SLM is that it can produce high performance end used metal 3D printed paths for industry applications including aerospace automotive and medical. Well, talk about binder jetting you see here there binder jetting is most commonly used for full color paths, low cost metal printing and large sand casting molds. In this particular process, there is a elevator system, there is a build building platform and then

the building material is supported and then it is fed to the injection printing heads is similar to injection printer. And then you have a UV curing lamp. Once you print it there is a UV will cure the material to get the final part and of course, there is a leveling head just to level up the printed part. So, binder jetting is mostly used when you want to make a colorful or may colorful paths whether a more than one 3D color involved.

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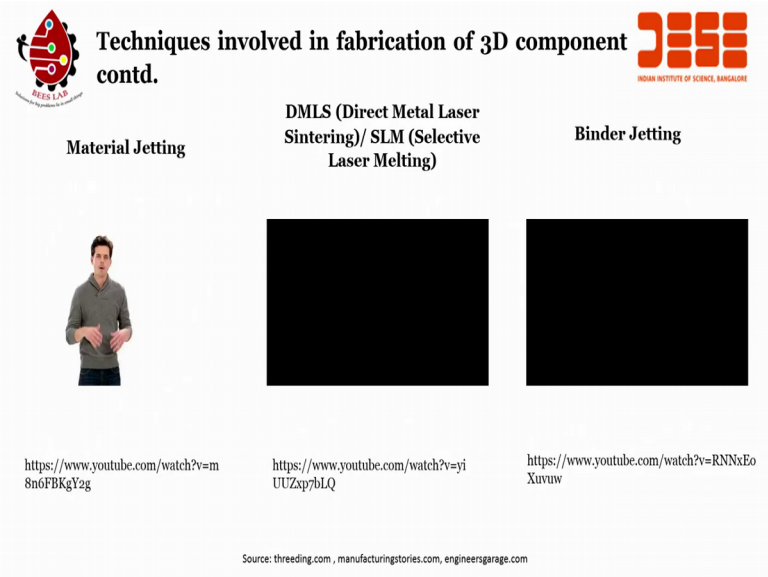

So, let us see now in detail the videos of material, jetting DMLs and binder jetting. I will play one by one. PolyJet which is 3D component method the makes beautiful precise models in a huge variety of materials and colors.

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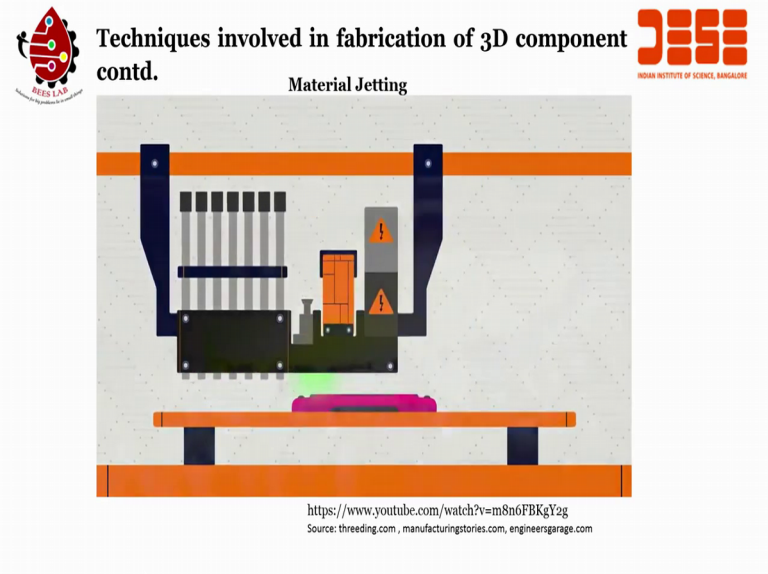

They works like an ink jet printer, but instead of jetting drops and ink PloyJet pretty printed is jet tiny drop us liquid plastic. A UV light is an liquid plastic solidifying it.

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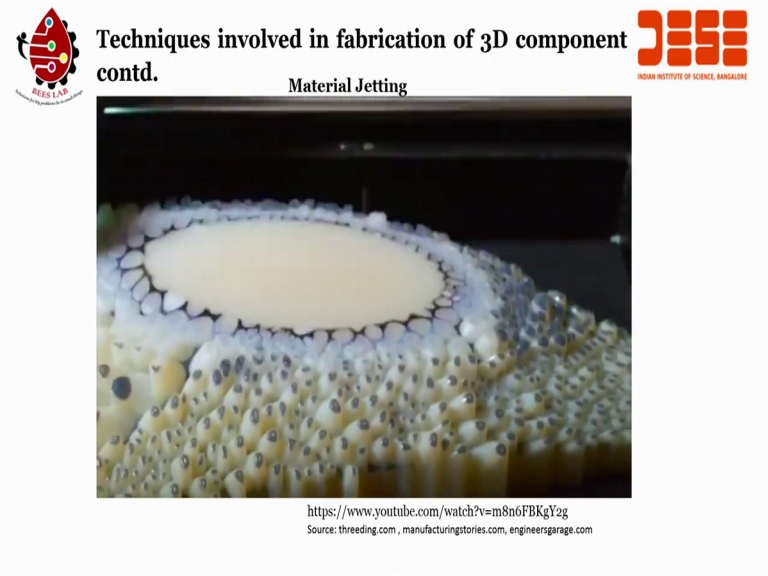

And so layer by layer complex models takes shape. The most advanced PolyJet systems can built multi material parts soft, rigid, clear and colorful.

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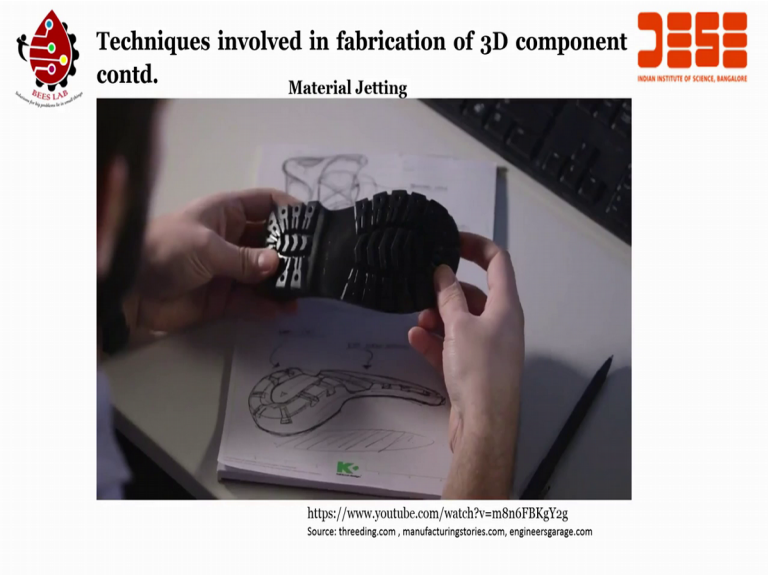

You can even adjust material properties like heat resistant and durability. The same technology that makes score this prototypes also makes precise manufacturing tools. Designers can predict future needs and serve them now.

Manufacturers deliver better products faster and with less waste. Researchers have new methods of saving life's. PolyJet is reshaping industries like film, fashion and medicine. It is helping people with great ideas improve the future. What is next?

So now, you have seen how the material jetting works right. So, let me play how the DMLs or SLM laser jetting works. I will play it here.

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Direct Metal Laser Sintering also known as DMLs is an additive manufacturing technology that creates metal parts directly from 3D CAD data without the need for tooling.

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DMLs utilizes a variety of metal and alloy materials such as stainless steel cobalt chrome and inconel to create strong durable parts and prototypes. DMLs is an excellent choice for functional metal prototypes high temperature applications and end use parts.

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The DMLs process begins in the same fashion as other layer additive manufacturing technologies. A program takes 3D cad data and mathematically slices it into 3D cross sections each of these sections will act as a blueprint telling the DMLs machine exactly where to center the metal material. The data is then transferred to the DMLs equipment.

A recoder assembly pushes powdered metal material from the powder supply to create a uniform layer over the base plate. A laser, then draws a 2D cross section on the surface of the build maternity eating and fusing the material. Once a single layer is complete, the base plate is lowered just enough to make room for the next layer more material is raised from the cartridge when recoded evenly on the previously centered layer.

The DMLs machine used to center layer upon layer building from the bottom up as the part is built support structures are added to give supplemental strength behind features and overhanging surfaces. The completed part is been removed from the base play had treated with an age hardening process to further harden apart. Any support structures are also removed at this time. The numerous surface treatment hand polishing options available through service providers since, DMLs parts can be used in highly cosmetic applications. Typical uses for DMLs include tools and manufacturing aids, small integrated structures, dental components, surgical implants and aerospace parts ok.

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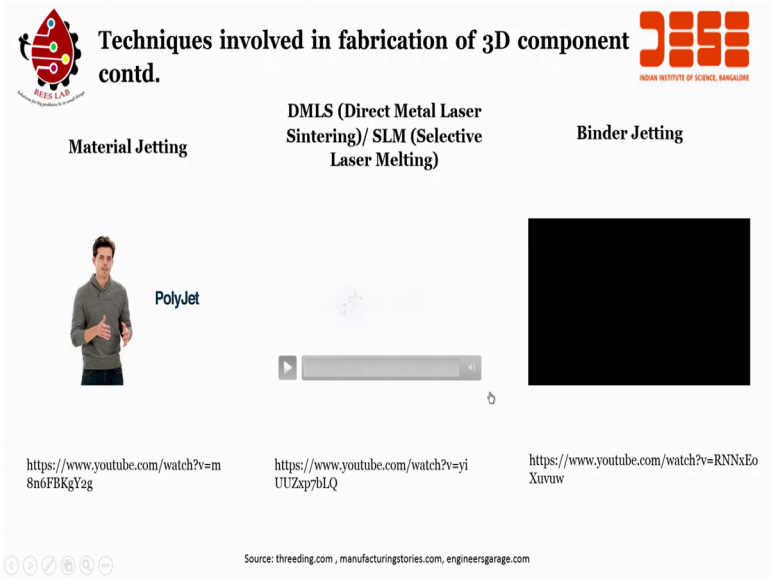

So, now you have also seen how DMLs or SLM laser sintering works. Let me a play now binder jetting.

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Binder jetting additive manufacturing is a process inspired by the technology of inkjet printers.

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In this process, a liquid binder is selectively deposited on a powder bed with a print head. It is a growing process that allows the production of parts for the manufacturing medical and dental industries. This technique enables the production of metallic and ceramic parts as well as sandal stochastics. Just try the process a 3D drawing is imported into the printer software.

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The powder to be used is placed in a dispenser which ensures a constant supply during printing.

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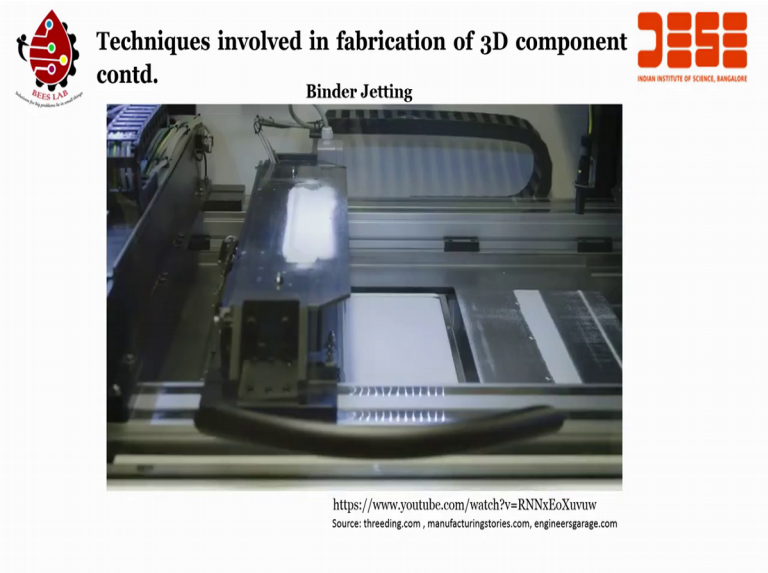

First a powder layer of a specific thickness is prime. Thereafter the printing head moving on two axes projects the binder wears necessary. Before moving on to the next layer the solvent contained in the binder is evaporated by an Indian their supplier. The powder bed is then lowered and a new powder layer is deposited. Therefore, the production takes place in a series of steps that build the part layer by layer. When the cycle is completed

the binder is cured by placing the container in a furnace. The temperature and time depend on the type of binder employed during printing after. This step unbound particles are removed to reveal the part or the mold. After this step the sand molds are ready to be used in foundries. The metal and ceramic parts must undergo sintering in filtration heat treatment or hot isostatic pressing before being used ok.

So, now, what you see here is that we can have different techniques to fabricate that there are involved in fabrication of 3D component right. In the in the next class what we will see is how can we have different kind of sensors printed using 3D printing. So, far this is the end of this particular module and I hope that you know you, you go through the videos you understand the technique. The idea here is to help you out to look at different techniques available and then based on those techniques, how can we used how can we use either the material or the combination of material with a particular technique for fabricating a particular module and that module can be used.

There can be when i am saying module it can be also implant right. It can be also something which can be used in aerospace component may use in medical devices; it can be used in electronics packaging. So, depending on what kind of application that you want to work on, you have to select the combination of a material and with resp and accordingly the technique that can be used for 3D printing. So, the next class, I will tell you how you can use 3D printer for sensors and how can you package those sensors using 3D printing.

Till then you take care, I will see you in the next class. If you have any questions please ask me in a forum right either me or my TA would really will be you know we are working really hard to attain all the questions that you ask and wherever possible we are trying to answer all the questions you know that you generally put over the forum.

In case you still have detailed question where you think that forum it may not be right place to ask, you are you can fill free to ask me through my email id. You can send an email to my to me addressing please put the information about the course and then ask me a question. Make sure that it is not a it is something that you cannot get it as an answer in a forum. If you get the answers the forum, you do not have to send me a separate request, but if you do not get a answer to forum and you think that you are really

confused, then please fill free to send me an email. I will try to answer your query as soon as I can all right.

So, look at this; I will see you next class until then you take care bye.