

3D printing and its applications

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Acc.V Spot Magn Det WD Exp | 100 μ m
12.0 kV 4.0 350x MIX 14.0 1
2011-12-20 B3FL; 20xSD; Azadi

Manufacturing a 3D object

There are 4 different ways to manufacture a 3D object

1. Subtractive manufacturing

ساخت به روش کاهشی

2. Formative manufacturing

ساخت به روش شکل دهی

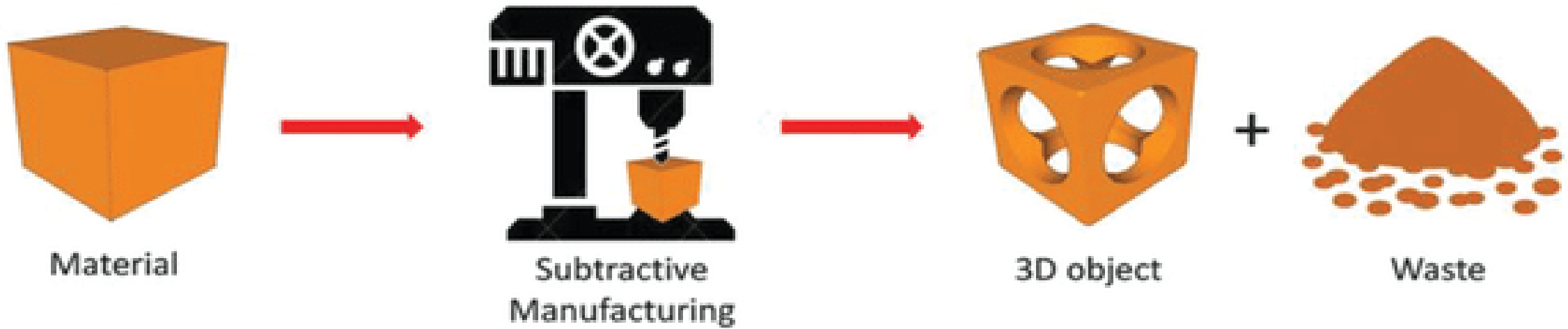
3. Casting manufacturing

ساخت به روش ریخته گری

4. Additive manufacturing

ساخت به روش افزودنی

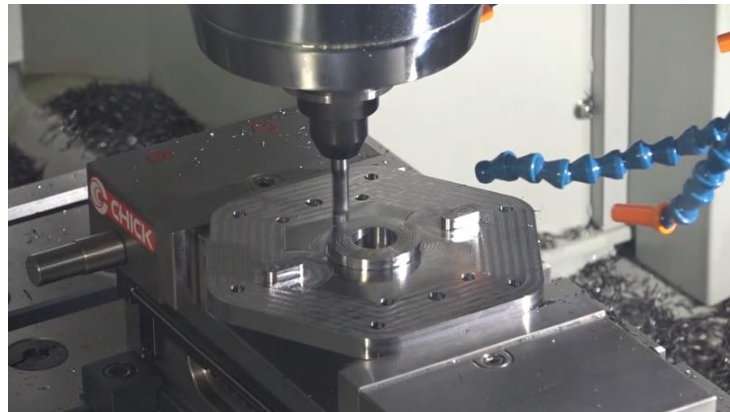
Subtractive Manufacturing



خراطی Turnery



تراشکاری milling

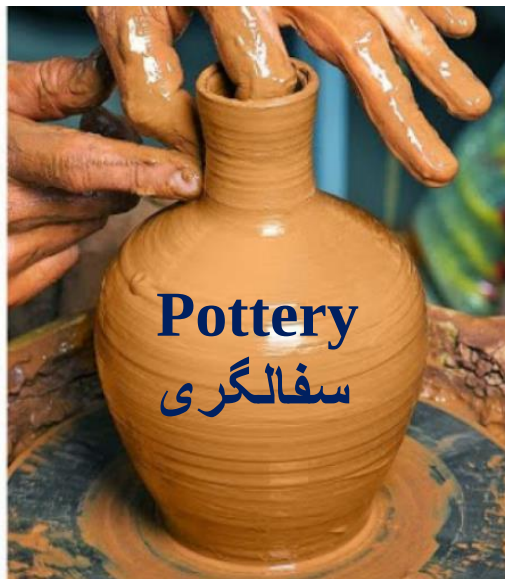


منبت کاری Woodcarving مجسمه سازی Sculpture



Formative Manufacturing

Soft materials such as mud, paste, sheet of plastic or metals are formed by applying pressure



Casting Manufacturing

Melting materials such as metals, glass or plastics and then pour in a mold



Mold



Automobile



Aerospace



Railways



Shipping



Farming



Machine Tool



Machinery



Electrical



Energy



Defense



Sanitary



Home Fittings



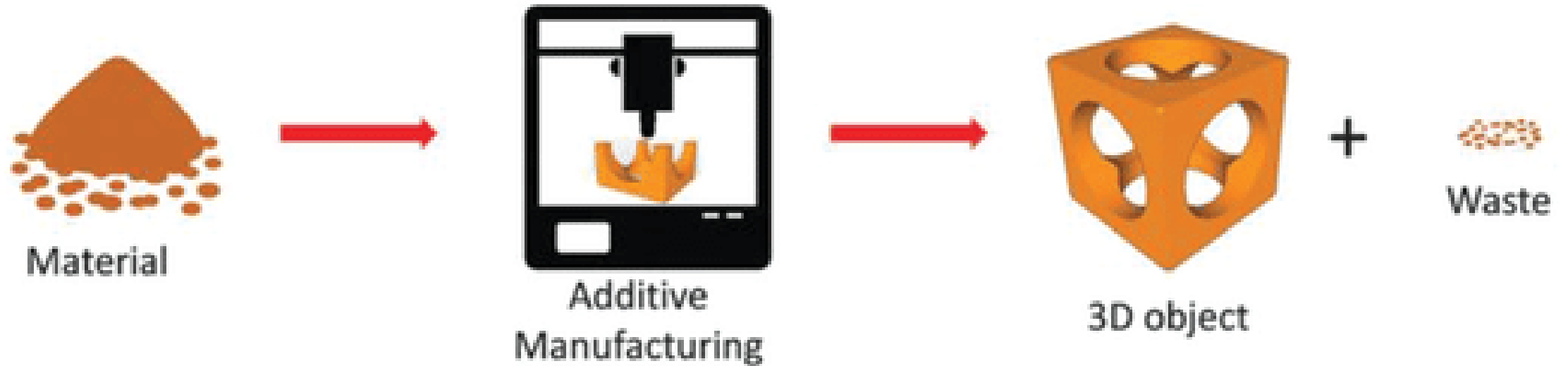
Medical



Art

Additive Manufacturing

Materials are added together layer by layer to build a desired 3D object



By additive manufacturing it is feasible to produce any complex structure as a single part using various materials such as polymers, plastics, metals, ceramics, concrete and even chocolate.

Additive Manufacturing = 3D Printing

The process of 3D printing consists of 4 steps:

1. **CAD model:** creating the 3D digital model using a software like Solid-work. The final file should be saved in the stereolithography file format (STL).
2. **Slicing:** The STL file is send to the 3D machine software for slicing into many thin layers. The software creates G-codes for moving the stages in 3D.
3. **Structuring:** the 3D model is built in a layer-by-layer fashion.
4. **Post-processing:** the finished model is then post-processed to improve some properties



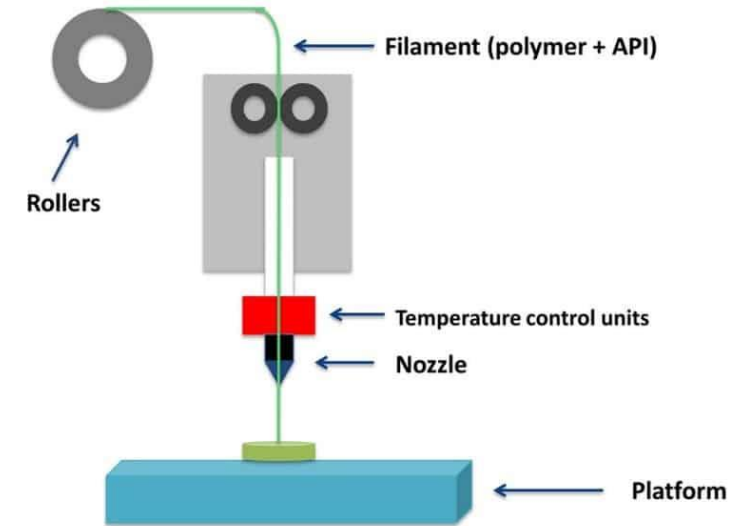
Different strategies for 3D Printing

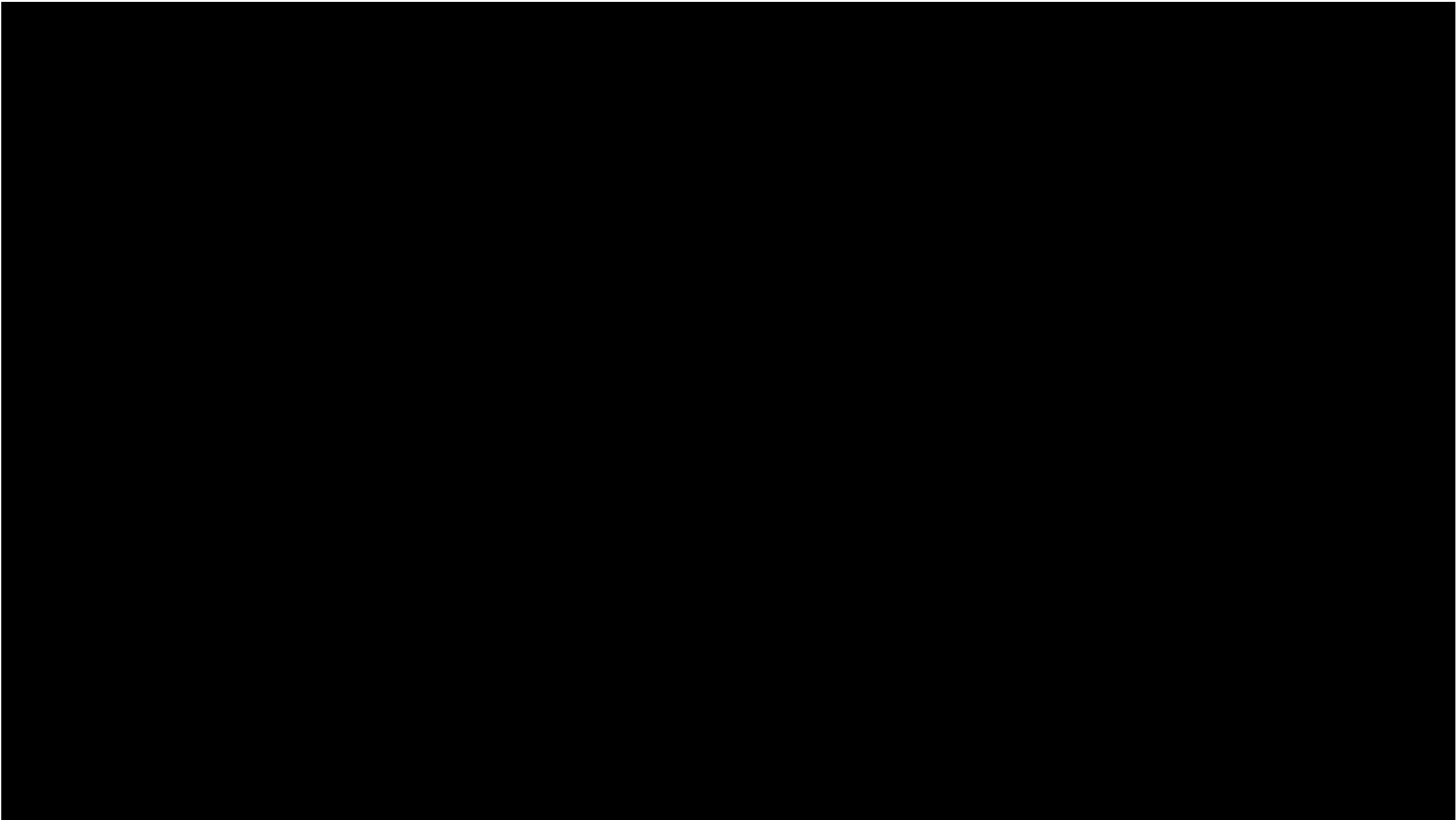
- 1. Material extrusion**
- 2. Powder bed fusion**
- 3. Direct energy deposition**
- 4. Material jetting**
- 5. Binder jetting**
- 6. Sheet lamination**
- 7. Vat photopolymerization**

1- Material extrusion

Fused deposition modeling (**FDM**) or Fused filament fabrication (**FFF**)

A filament of thermoplastic is fed into an extrusion nozzle head where the filament is heated to its melting temperature and extruded onto a build table.





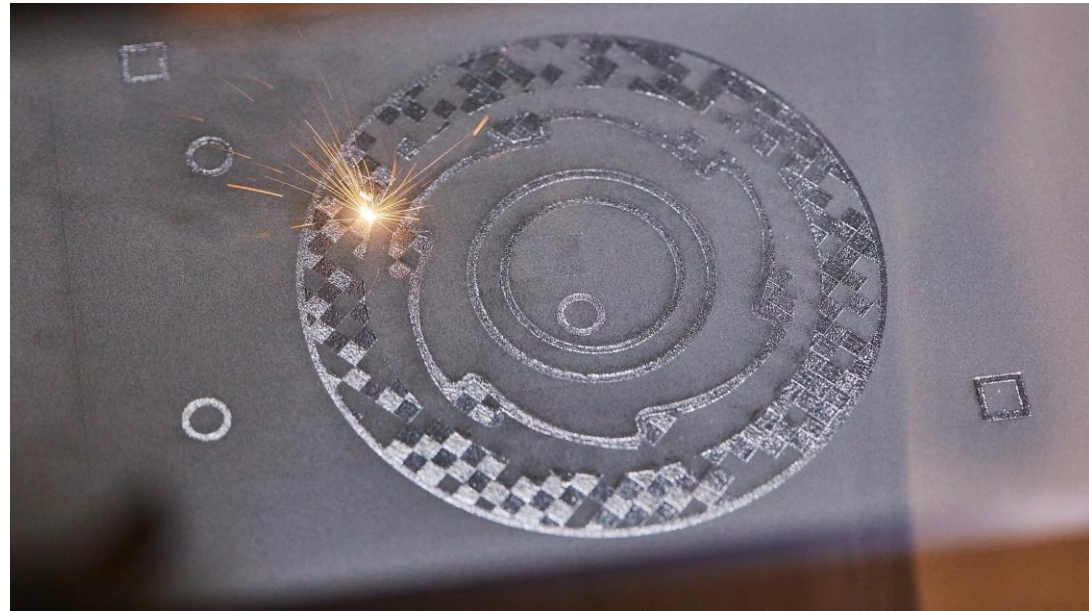
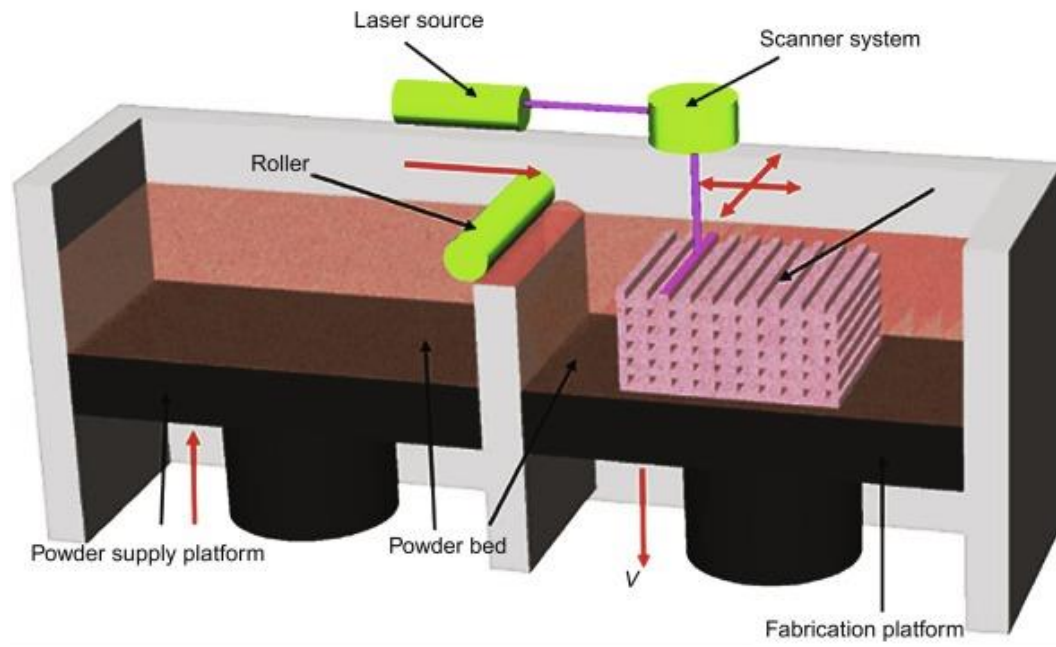
2- Powder bed fusion

A thin layer of powder (metal, plastic, ceramic or glass) is distributed on the building platform and the laser or electron beam is focused on the powder layer. The selected points irradiated by beam are fused together to create a cross section of the object. Then the platform moves down (e.g. 100 μm) and another layer of powder is distributed on the previous layer and the process is repeated until the object is created.

3 different 3D printers work based on this strategy:

1. Selective laser sintering (SLS)
2. Selective laser melting (SLM)
3. Electron beam melting (EBM)

SLS / SLM / EBM

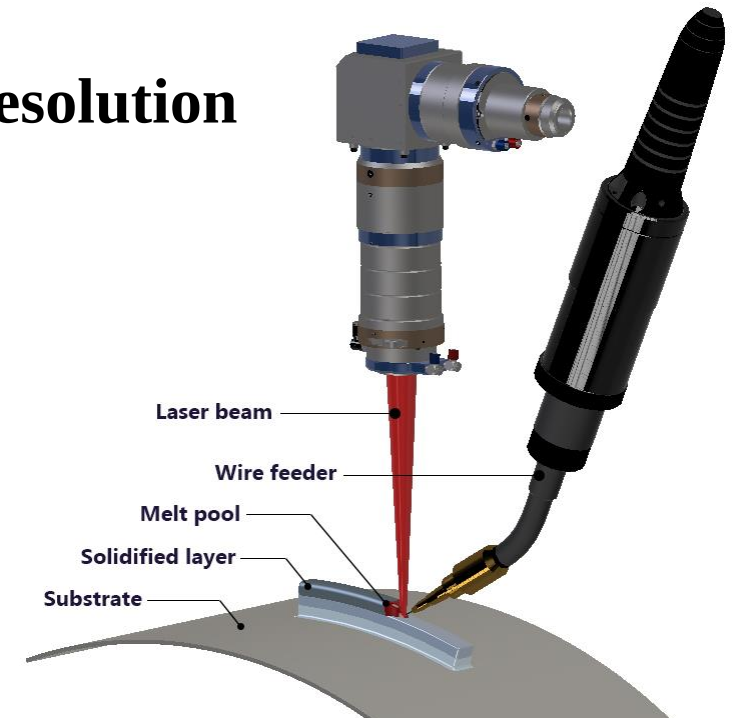
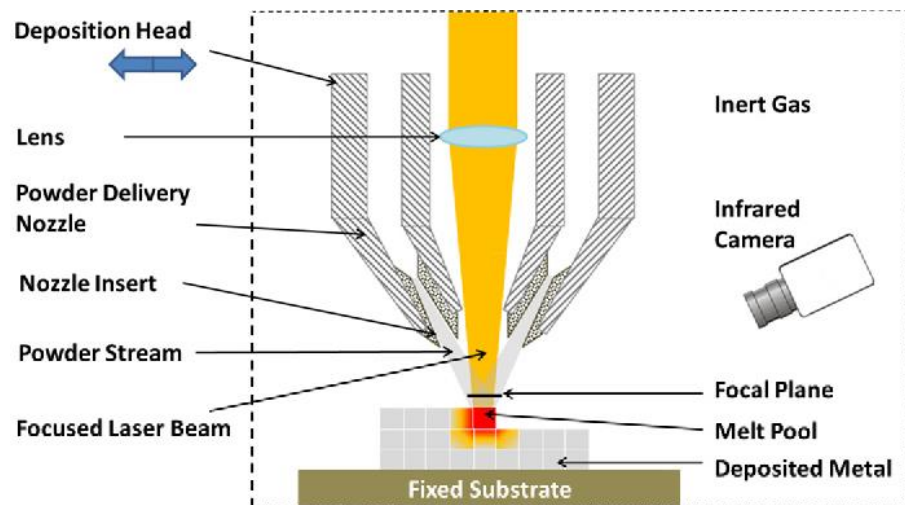


3- Direct energy deposition

In this method the powder is fed through a nozzle via which the laser beam emerges.

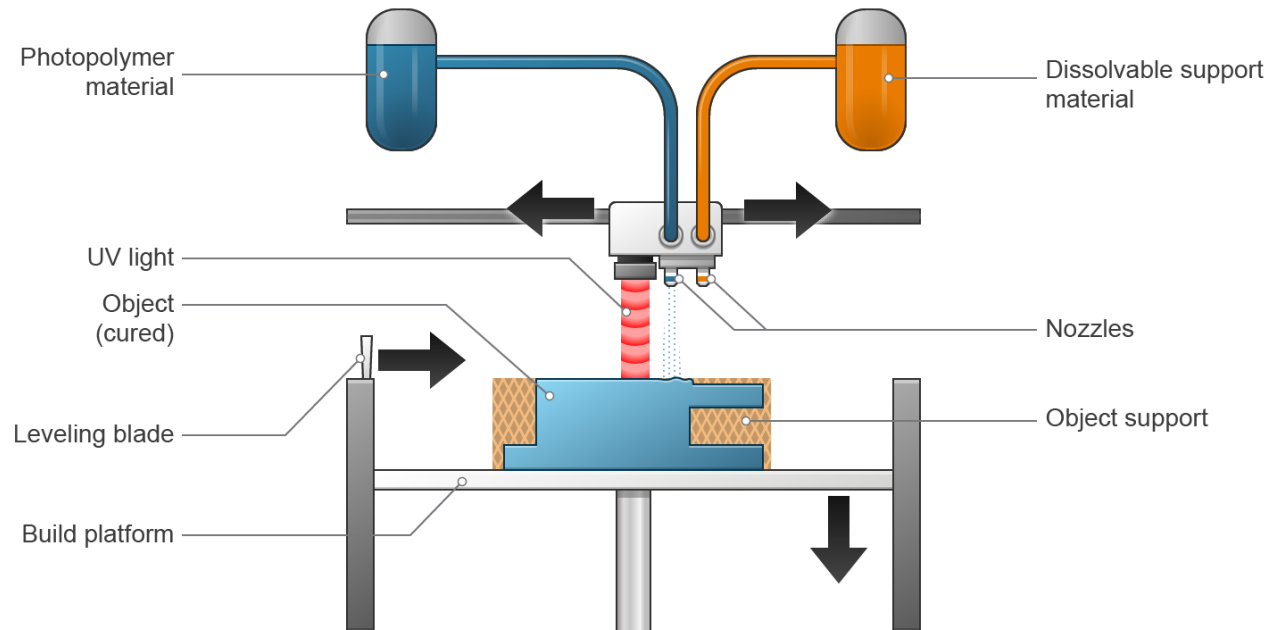
Instead of powder, a wire can be fed in front of the laser beam.
The rate of feeding depends on the laser power and scanning speed.

That is like arc welding with high precision and resolution



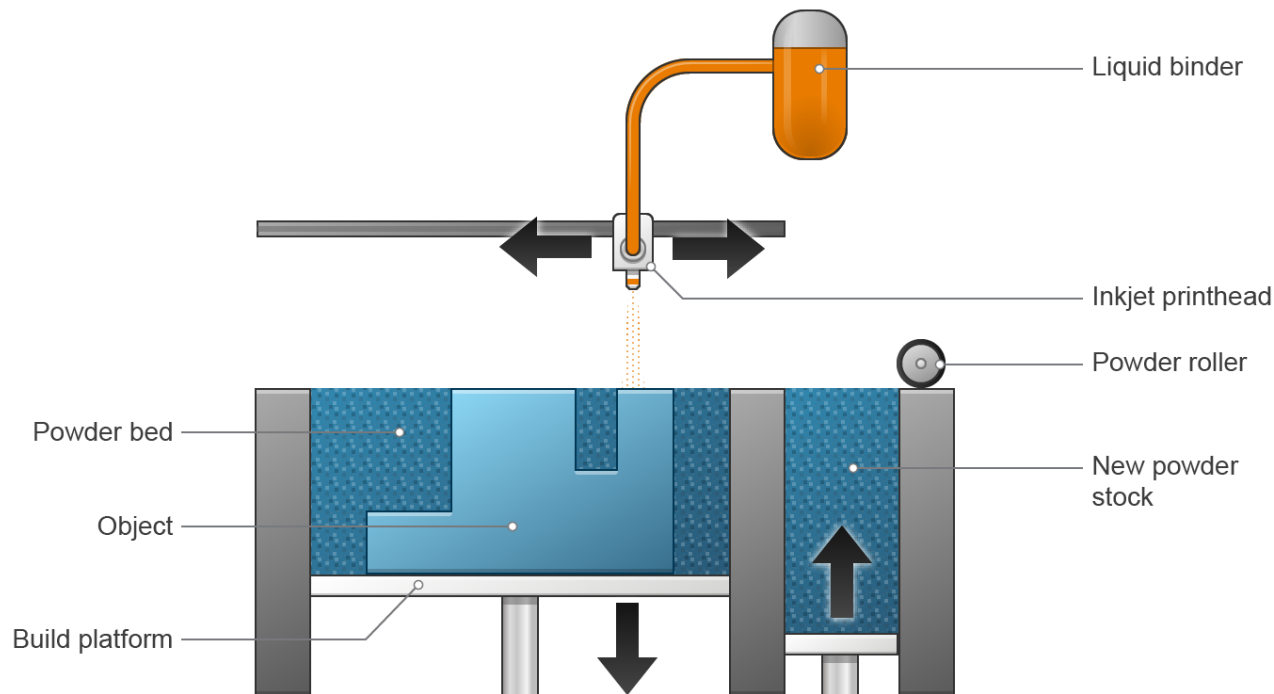
4- Material jetting

Material Jetting is an inkjet printing process whereby printheads are used to deposit a liquid photo-sensitive material onto a build platform layer upon layer. Similarly to Stereolithography (SLA), Material Jetting uses UV radiation to solidify the material.



5- Binder jetting

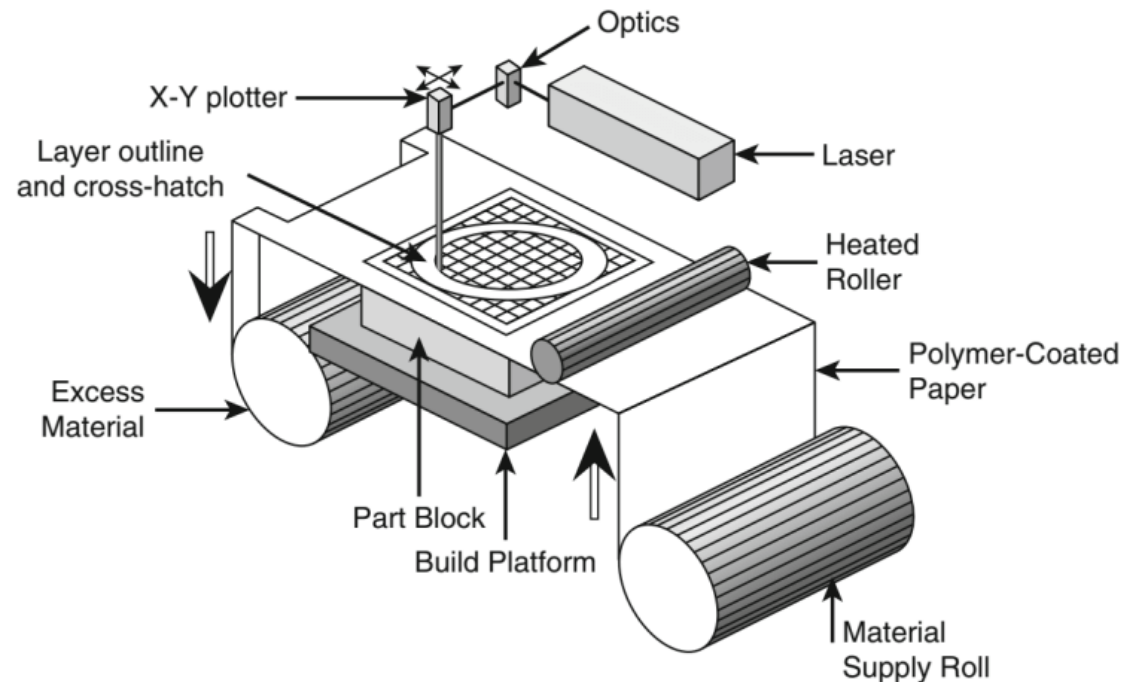
The binder jetting 3D printing technique consists of the deposition of a binding adhesive agent onto thin layers of powdered material. The powdered materials are either ceramic-based (for example glass or gypsum) or metal (for example stainless steel).



It is similar to powder bed technique but no laser or electron beam is used. Instead of heat source to fuse the powder grains together, the grains are glued together using an adhesive agent.

6- Sheet lamination

The Sheet Lamination (SL) 3D printing manufacturing technique, also known as Laminated Object Manufacturing (LOM), consists of super-positioning several layers of material composed of foil in order to manufacture an object. Each foil is cut to shape with a knife or laser in order to fit to the object's cross-section.



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7- Vat photopolymerization

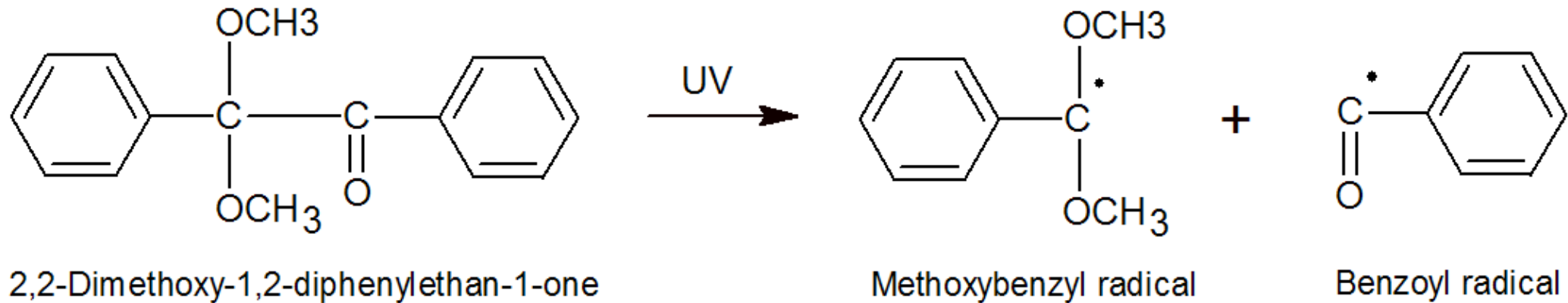
In this technique a photo sensitive liquid polymer (Resin) is solidified by radiation.

Resin is a mixture of liquid polymer (monomer) and a photo-initiator.

A photo-initiator is dissociated into free radical upon absorbing radiation

A Free radical is very aggressive and makes bond with a neighboring monomer producing longer molecule but remains still a free radical capable to bond to another monomer thus producing even longer molecule. In this way the polymerization is triggered and large amount of resin turns to polymer and thus solidified. Fortunately there are some chemical processes called self terminating processes which lead to terminate the photopolymerization. Otherwise the entire resin will solidify by just a single pulse of radiation.

photopolymerization



Depends on the kind of photo-initiator and the laser wavelength used for photopolymerization the physical process could be one-photon absorption (1PA) or two-photon absorption (2PA). In 1PA based photopolymerization the light radiation is UV. The light source could be a Laser or an LED. In 2PA based photopolymerization the light radiation should be IR. The light source should be a femtosecond Laser having wavelength in the range of 700-900 nm.

1PA based polymerization

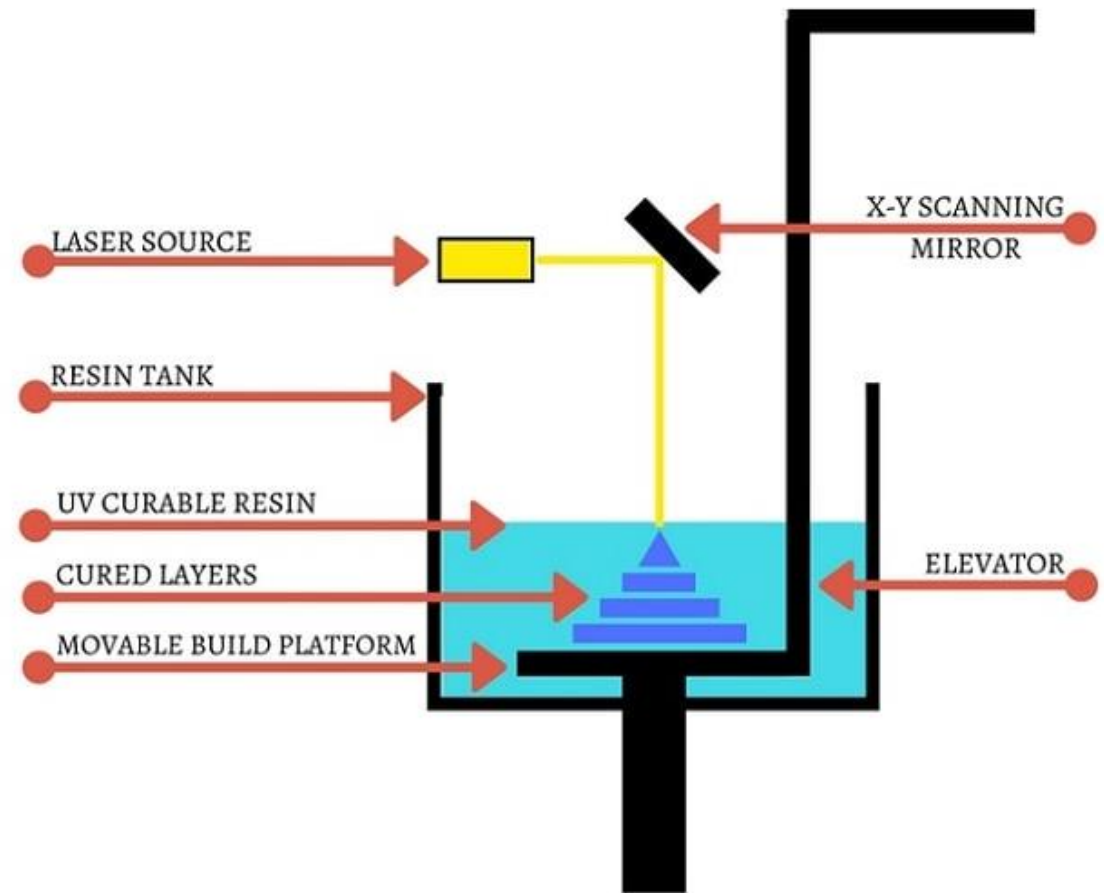
Like all other 3D printers, the 3D digital model is sliced in many layers with desired thickness. A thin layer of resin is distributed over the building platform. The resin layer is irradiated similar to the pattern of a given cross section of the 3D model. Then the platform is moved in vertical direction for the next layer. In this way a real 3D object is built according to the designed 3D model. When the structuring is finished the object is put in some solvent to wash out the residual resin and then irradiated by UV for short time to improve some mechanical properties.

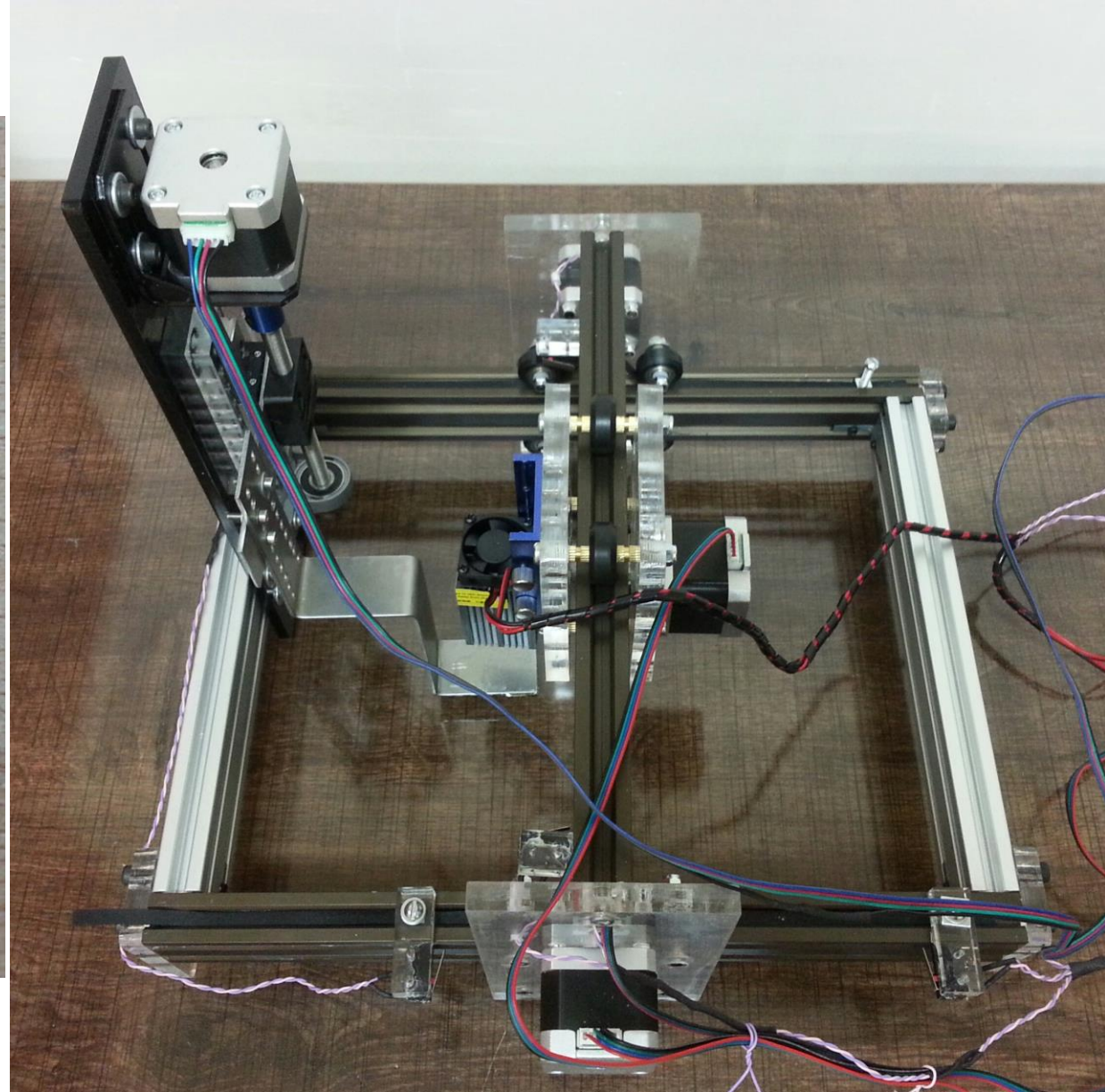
Depends on how a layer is built, two different machines are designed:

- Stereolithography (SLA)
- Digital light processing (DLP)

Stereolithography (SLA)

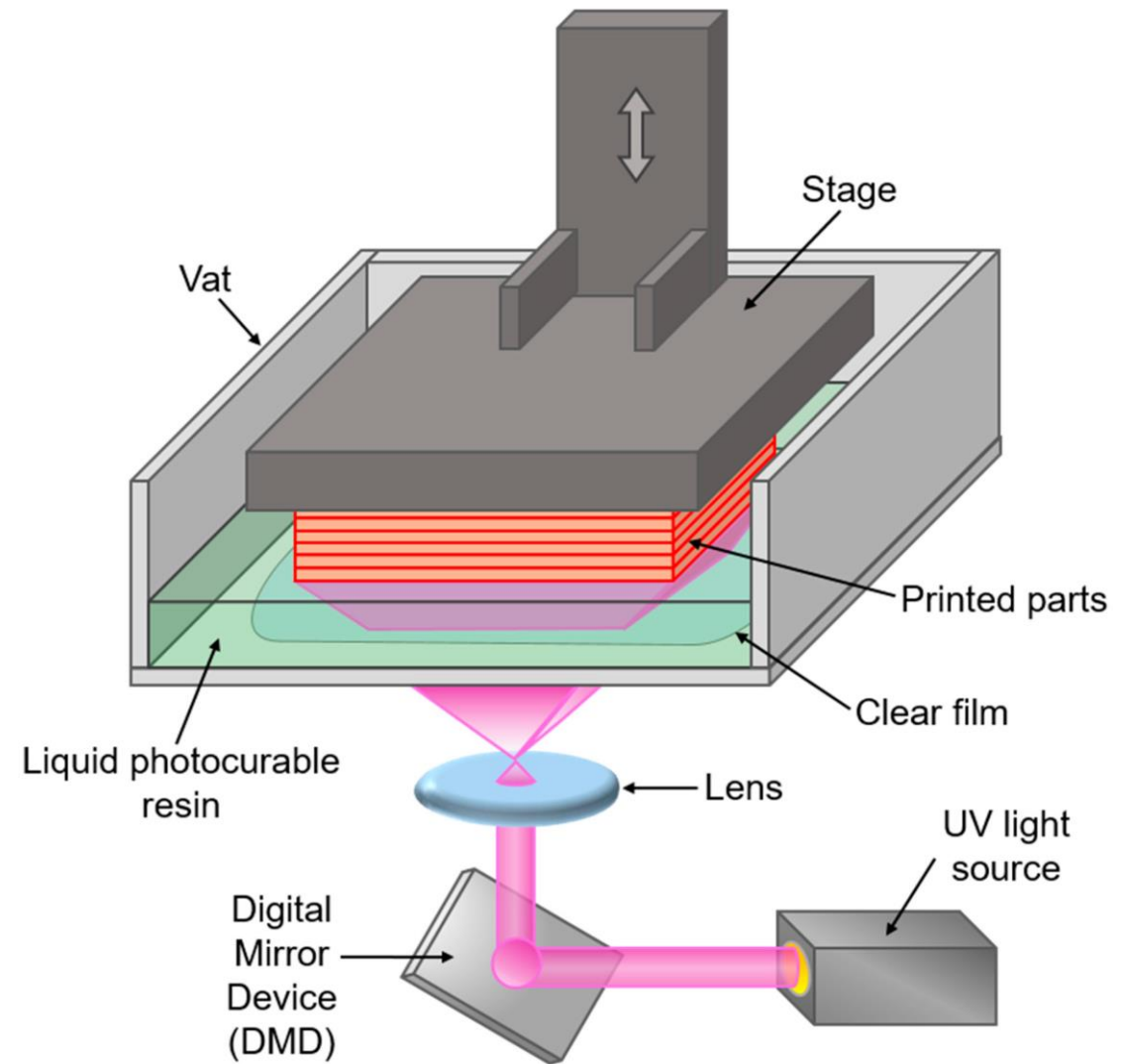
1. The Vat is filled with UV curable resin
2. The building platform is adjusted below the surface of resin
3. The UV laser beam is focused on the resin surface
4. Using a Galvo scanner or 2D translation stage the laser focus is scanned over the resin surface to produce a layer.
5. The platform moves in vertical direction for the next layer to be built
6. The finished 3D object is washed in a solvent





Digital light processing (DLP)

1. The Vat is filled with UV curable resin (not too much)
2. The building platform is adjusted close to the bottom of the vat since in DLP the light comes in bottom-up direction
3. The UV beam is irradiated on the surface of a Digital Mirror Device (DMD) connected to computer and controlled by the software.
4. The DMD reflects an image of the given layer. Thus, the resin layer is irradiated at once and the layer is created by just a one-time irradiation.
5. The platform moves in vertical direction for the next layer to be built
6. The finished 3D object is washed in a solvent

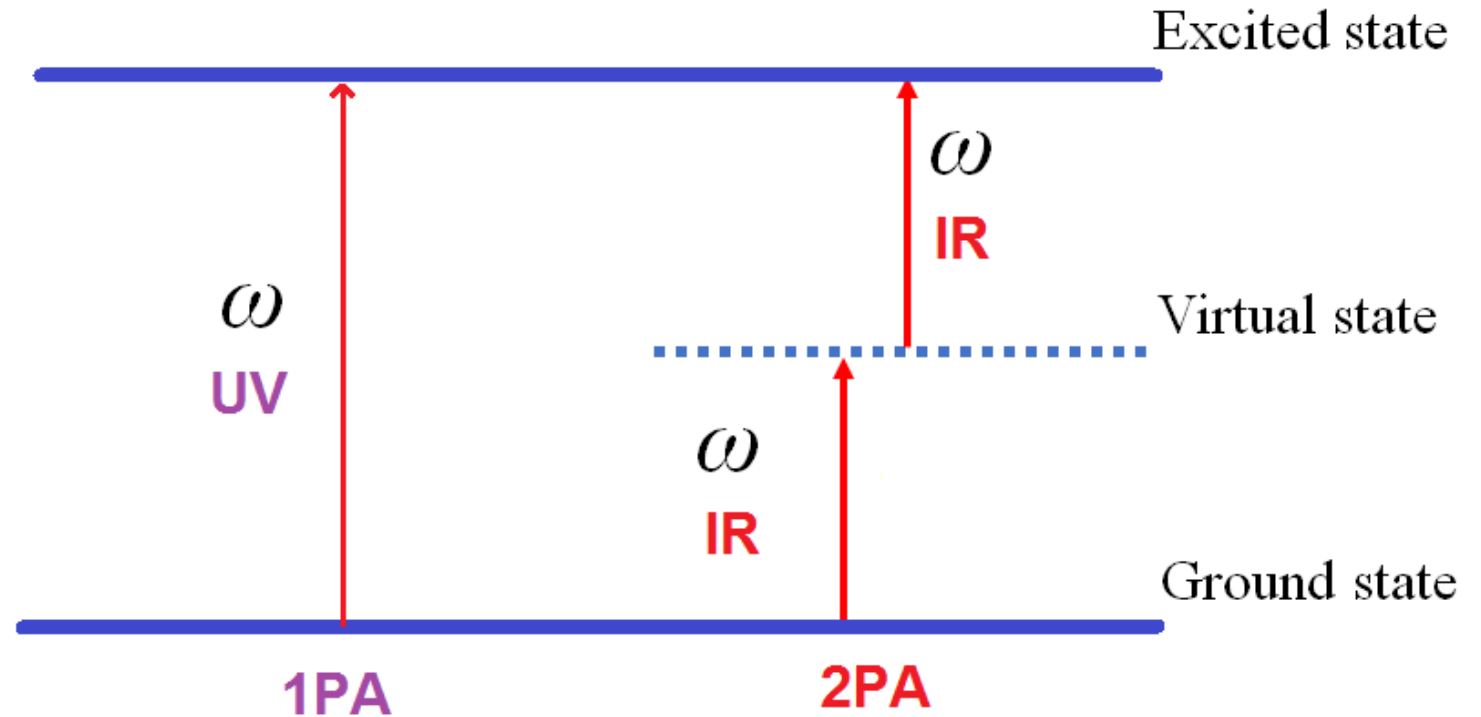


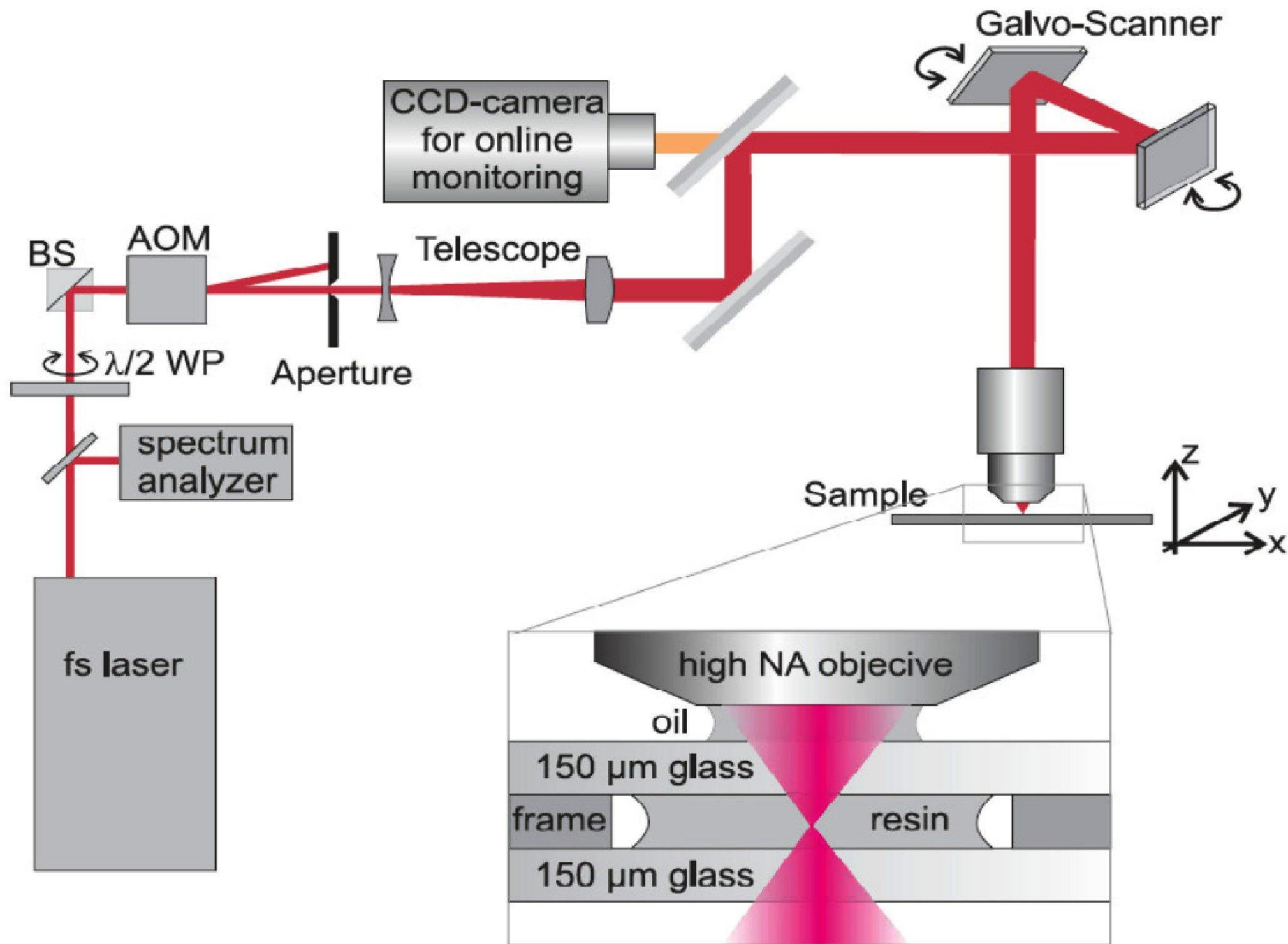
2PA based polymerization (2PP)

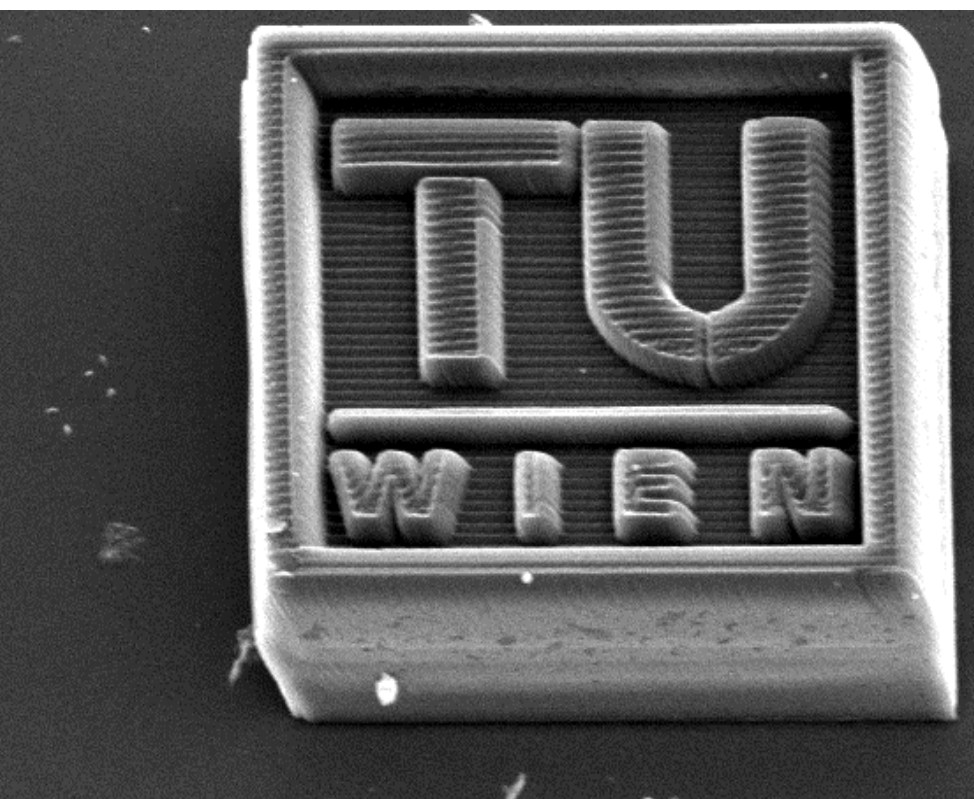
A transition from the ground state to an excited state can be occurred via absorption of a single photon or simultaneously multi-photon for instance two photons.

1PA: $\frac{dI}{dz} = -\alpha_0 I$

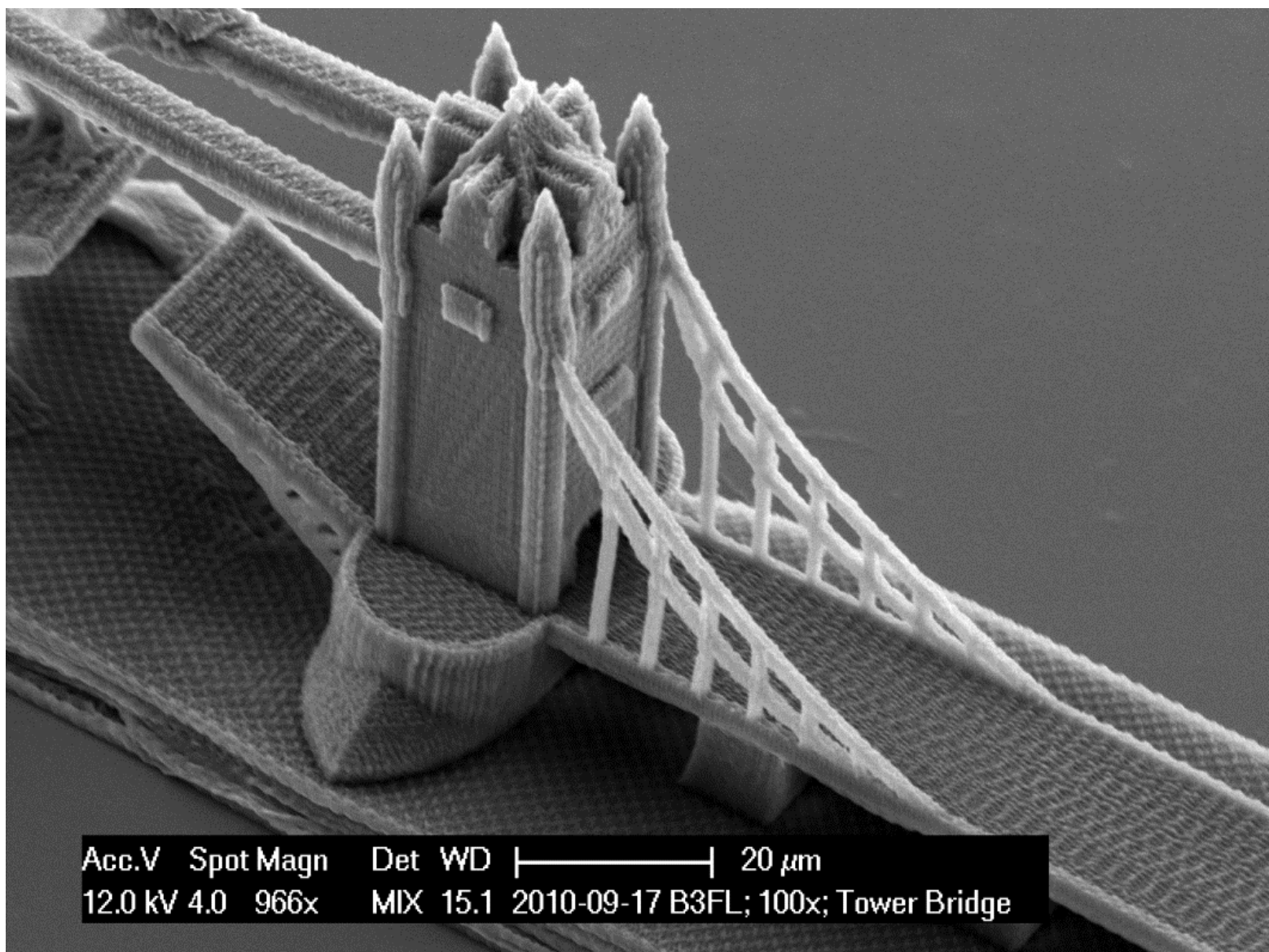
2PA: $\frac{dI}{dz} = -\alpha_2 I^2$







Acc.V Spot Magn Det WD Exp | 20 μ m
12.0 kV 4.0 1267x SE 29.8 1 2009-12-29 R1, 100x, Indy Cars



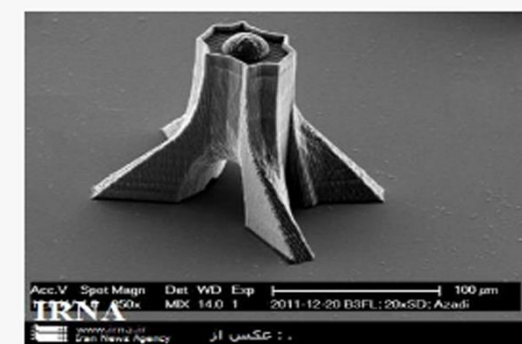
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12.0 kV 4.0 966x MIX 15.1 2010-09-17 B3FL; 100x; Tower Bridge

کد خبر: ۸۰۳۴۰۷۷۹ (۲۸۷۶۸۶۷) تاریخ خبر: ۱۳۹۱/۰۷/۰۴ ساعت: ۲۳:۵۶

با بهره گیری از نانو تکنولوژی:

محقق ایرانی 'برج آزادی' تهران را به دانشگاه وین برد

وین - یک محقق کشورمان که مشغول تحقیق در دانشگاه صنعتی وین در کشور اتریش است موفق شد یک مدل سه بعدی برج آزادی تهران را با ضخامت یک برگ کاغذ (۱۰۰ میکرون) بسازد.



به گزارش ایرنا، 'علی اصغر عجمی' که اینک سال آخر دکتری فیزیک اتمی را در دانشگاه صنعتی وین می گذراند درباره این موفقیت به خبرنگار ایرنا گفت: ارتفاع ۵۰ متری برج آزادی در این مدل حدود ۵۰۰ هزار بار کوچکتر شده در حالی که تمام مشخصات جزئی برج در این ماکت قابل مشاهده است به طوری که تصویر گرفته شده توسط میکروسکوپ الکترونی از این مدل، شبیه عکس گرفته شده از برج آزادی است.

این محقق افزود: این به دلیل آن است که ضخامت خطوط پلیمری تشکیل دهنده این ساختار حدود ۱۰۰ نانومتر است، پس می توان کار انجام شده را در حوزه نانو تکنولوژی طبقه بندی کرد.

عجمی خاطرنشان کرد: وقتی صحبت از نانو تکنولوژی به میان می آید منظور تولید ساختارهایی است که اندازه یک بعد آن کمتر از ۱۰۰ نانومتر باشد.

وی یادآور شد: هدف نهایی در این پروژه، تولید ساختارهای سه بعدی پلیمری با استفاده از لیزر است.

عجمی توضیح داد: مدل هر ساختار سه بعدی دلیخواه به کمک برنامه رایانه ای رسم شده و مطابق آن دستور لازم از رایانه به ماشین پلیمر ساز ارسال می شود.

این محقق ایرانی تاکید کرد که از ساختارهای تولید شده می توان با استفاده از میکروسکوپ الکترونی عکس گرفت.

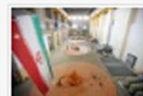
اروپام ** ۱۳۴۴ ** ۱۰۸۰ ** ۱۵۹۷

گالری تصاویر



پربیننده ترین ها

☞ سومین واحد
تیرگاه سد گتوند علیا
وارد مدار شد



☞ معاون هماهنگ کننده
نیروی هوایی در گفت و گو
با ایرنا:



☞ نسل جدید جنگنده
صاعقه تا پایان سال وارد
تاوان هوایی می شود

اینترنشنل سرویس:



☞ نماینده ایران
در آژانس از پیشنهاد
توقف غنی سازی ۲۰
درصد خبر داد

☞ روزنامه آمریکایی:

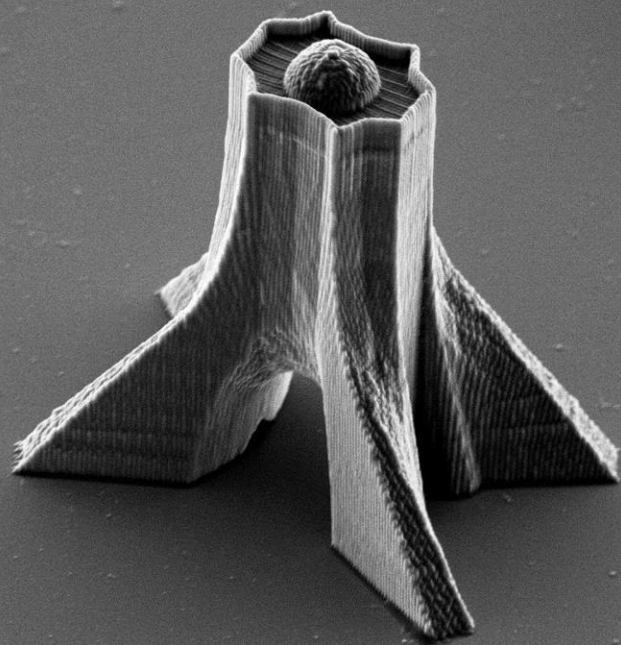


واکنش نظامی ایران
ویرانگر خواهد بود

☞ پاسخ هایی که



رئیس جمهوری داد -
از فعالیت های صلح
آمیز هسته ای ایران تا



Acc.V Spot Magn Det WD Exp | 100 μm
12.0 kV 4.0 350x MIX 14.0 1 2011-12-20 B3FL; 20xSD; Azadi