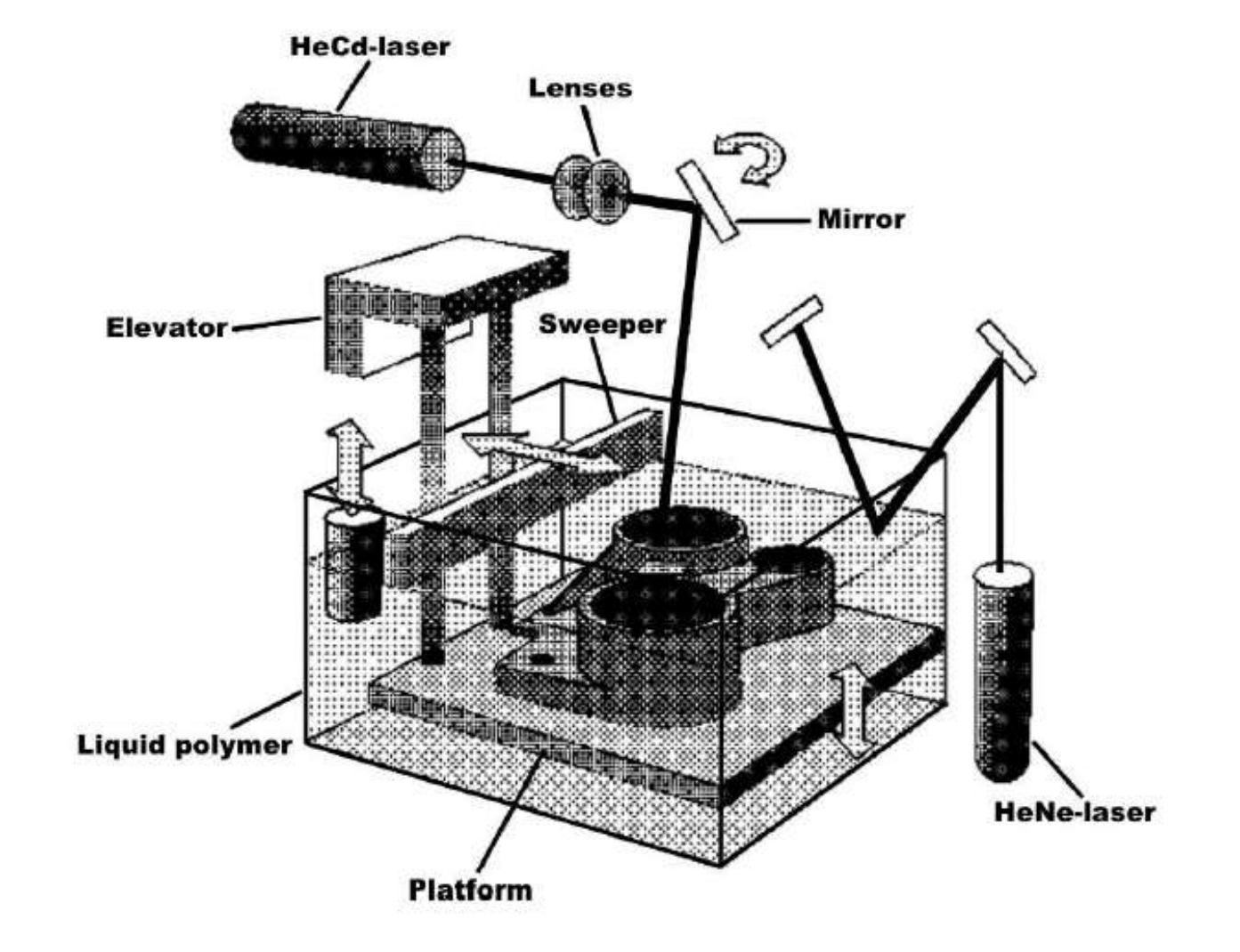
Introduction of Stereo Lithography

- It is the first RP system developed by **3D SYSTEMS** of Valencia in California, USA in **1996 (first version in 1987).**
- First Model developed was 250/50 followed by 250/30, 3500, 5000 and 7000.
- SLA is a laser based Rapid Prototyping process which builds parts directly from CAD by curing or hardening a photosensitive resin with a relatively low power laser.
- StereoLithography (SL) is the best known rapid prototyping system.
- The technique builds three-dimensional models from liquid photosensitive polymers that solidify when exposed to laser beam.

Introduction of Stereo Lithography

Model	250/30	250/50	3500	5000	7000
Laser Type	HeCd	HeCd	Solid State	Solid State	Solid State
Laser Power	12 mW	24 mW	160 mW	216 mW	800 mW
Laser Life	2,000 hrs	2,000 hrs	5,000 hrs	5,000 hrs	5,000 hrs
Recoat	Blade	Zephyr	Zephyr	Zephyr	Zephyr
Min. Slice	0.006"	0.004"	0.002"	0.002"	0.001"
Beam Diam.	0.008"	0.008"	0.008"	0.008"	variable
Scan Speed	30 in/sec	30 in/sec	100 in/sec	200 in/sec	variable
Max Part Vol.	10x10x10"	10x10x10"	14x14x16"	20x20x23"	20x20x23"
Max Part Wt.	20 lb	20 lb	125 lb	150 lb	150 lb

Principle of Stereo Lithography



Principle of Stereo Lithography

- The model is built upon a platform in a vat of photo sensitive liquid.
- A focused UV laser traces out the first layer, solidifying the model cross section while leaving excess areas liquid.
- In the next step, an elevator lowers the platform into the liquid polymer by an amount equal to layer thickness.
- A sweeper recoats the solidified layer with liquid, and the laser traces the second layer on the first.
- This process is repeated until the prototype is complete.
- Afterwards, the solid part is removed from the vat and rinsed clean of excess liquid.
- Supports are broken off and the model is then placed in an ultraviolet oven for complete curing.

Process Parameters of Stereo Lithography

a. Laser Type: **Helium Cadmium Laser**
b. Laser Power: **24mW**
c. Laser Life: **2000 hours**
d. Re-coat material: **Zaphir**
e. Minimum Slice Thickness: **0.1mm**
f. Beam Diameter: **0.2mm**
g. Scan Speed: **0.75m/sec**
h. Maximum Part Volume: **0.25x0.25x0.25 m**
i. Maximum Part Weight: **9 kgs (approx)**

Application Range of Stereo Lithography

- Processing large variety of photo-sensitive polymers including clear, water resistant and flexible resins
- Functional parts for tests
- Tools for pre series production tests.
- Manufacturing of medical models
- Manufacturing of electro-forms for Electro Discharge Machining (EDM)
- Form-fit functions for assembly tests.

Adavantages/disadvantages of Stereo Lithography

Advantages:

- Possibility of manufacturing parts which are impossible to produce conventionally using a single process.
- Continuous unattended operation for 24 hours.
- High resolution.
- Any geometrical shape can be made with virtually no limitation.

Disadvantages:

- Necessity to have support structures
- Accuracy not in the range of mechanical part manufacturing.
- Restricted areas of application due to given material properties.
- Labour requirements for post processing, especially cleaning.

Software for Stereo Lithography

(i). SLA CONTROL AND SET UP SOFTWARE:

It operates on SLA 250 and SLA 500 machines. It has got three packages.

a) SLA VIEW: UNIX based system for viewing and positioning.

b) BRIDGE WORKS: UNIX based software for generating support structures.

c) SLA SLICE: Slicing and system operation software.

(ii) MAESTRO: UNIX based software

(iii) MS WINDOWS NT SOFTWARE (3D LIGHT YEAR):

It is used for viewing, positioning, support generation and slicing, build station for operating SLA machine.

Build material for Stereo Lithography

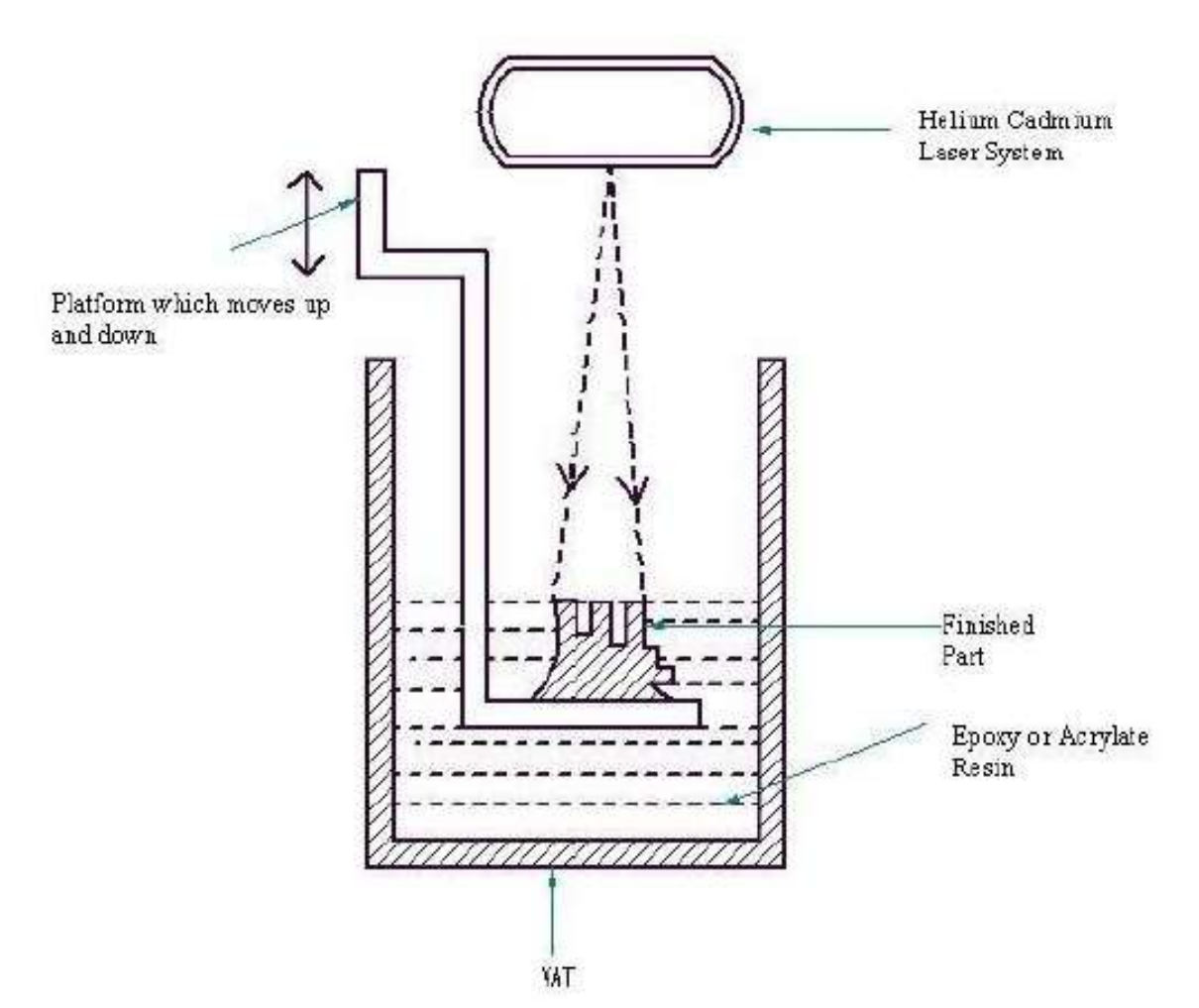
- Epoxy Resin, Acrylate Resin
- Epoxy Resin has better material properties and less hazardous but require large exposure time for curing.

Hardware for Stereo Lithography

The build chamber of SLA contains;

1) A removable VAT that holds the build resin.
2) A detachable perforated build platen on a Z axis elevator frame
3) An automated resin level checking apparatus
4) VAT has a small amount of Z movement capability which allows computer to maintain a exact height per layer.
5) A recoated blade rides along the track at the top of the rack and serves to smooth the liquid across the part surface to prevent any rounding off edges due to cohesion effects.
6) Some systems have Zaphyrrecoater blade which actually softens up resin and delivers it evenly across the part surface.
7) Behind the build chamber resides the laser and optics required to cure resin.
8) Laser unit is long rectangular about 4 feet long and remains stationary.

Stereo Lithography Appartus



Stereo Lithography Appartus Operation

1) The process begins with the solid model in various CAD formats
2) The solid model must consist of enclosed volumes before it is translated form CAD format into .STL FILE
3) The solid model is oriented into the positive octant of Cartesian coordinate system and then translate out Z axis by at least 0.25 inches to allow for building of supports
4) The solid model is also oriented for optimum build which involves placing complex curvatures in XY plane where possible and rotating for least Z height as well as to where least amount of supports are required
5) The .STL FILE is verified
6) The final .STL FILE one which supports in addition to original file are then sliced into horizontal cross sections and saved as slice file.
7) The slice files are then masked to create four separate files that control SLA machine ending with 5 extensions L, R, V and PRM.

Stereo Lithography Appartus Operation

8) Important one is V file. I.e. Vector file. The V file contains actual line data that the laser will follow to cure the shape of the part.
9) R file is the range file which contains data for solid or open fields as well as re-coater blade parameters.

The four build files are downloaded to SLA which begins building supports with platen adjust above the surface level.

The first few support layers are actually cured into perforations into platen, thus providing a solid anchor for the rest of the part.

By building, SLA uses laser to scan the cross section and fill across the surface of resin which is cured or hardened into the cross sectional shape.

The platen is lowered as the slices are completed so that more resin is available in the upper surface of the part to be cured.

Stereo Lithography Appartus Operation

Final step is Post Processing.

1) Ultraviolet Oven (Post Curing Apparatus)
2) An Alcohol Bath.

Clean the part in the alcohol bath and then go for final curing.

Stereo Lithography Appartus Advantages/Disadvantages/Application

Advantages:

1. Parts have best surface quality
2. High Accuracy
3. High speed
4. Finely detailed features like thin vertical walls, sharp corners & tall columns can be fabricated with ease.

Disadvantages:

1. It requires Post Processing. i.e. Post Curing.
2. Careful handling of raw materials required.
3. High cost of Photo Curable Resin.

Applications:

1. Investment Casting.
2. Wind Tunnel Modelling.
3. Tooling.
4. Injection Mould Tools.