

LIGA Lithography



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Definition of LIGA



- LIGA is a German acronym that stands for Lithographie, Galvanoformung and Abformung.
- When translated it means lithography, electroplating and molding.

Background



- LIGA is a three stage micromachining technology used to manufacture high aspect ratio microstructures.
- Originally LIGA technology was researched in Germany in order to be used for the separation of uranium isotopes.
- Henry Guckel of the University of Wisconsin brought LIGA technology to the USA.

Background



- Two main types of LIGA Technology: X-ray LIGA and Extreme Ultraviolet (EUV) LIGA.
- X-ray LIGA can fabricate with great precision high aspect ratio microstructures.
- EUV LIGA can fabricate lower quality microstructures.

LIGA Process



- LIGA is a hybrid fabrication technique
- The LIGA Process
 - Lithography
 - ✦ Electron beam lithography
 - ✦ Focused ion beam lithography
 - ✦ Optical and excimer laser lithography
 - ✦ Deep X-ray lithography using synchrotron radiation
 - Electroplating
 - ✦ metalized layer (seed layer)
 - Molding
 - ✦ Machining process to remove overplated metal region

Function of LIGA



- To produce high aspect ratio
- To manufacture 3-D microstructures from a wide variety of materials

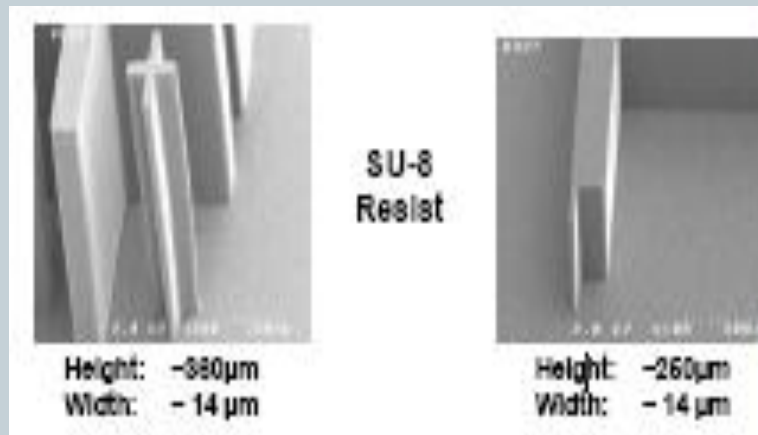
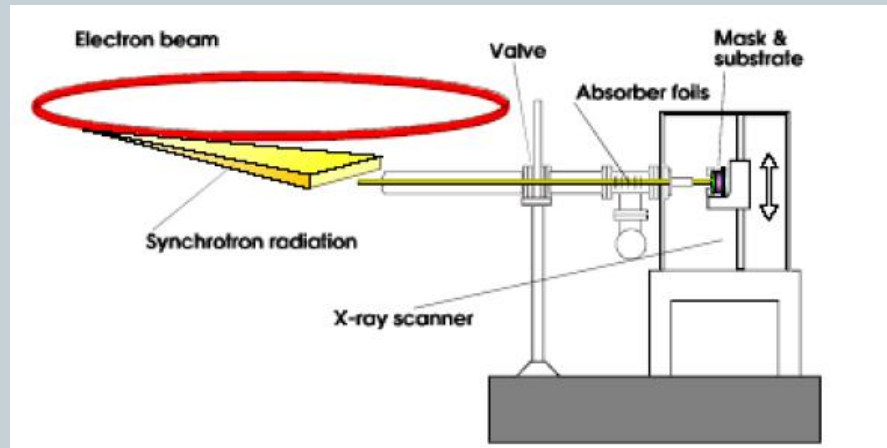


Figure1: 3-D microstructure

Lithography



- Deep X-ray lithography
 - Historically chosen as a source for LIGA process
 - superior to optical lithography
 - ✦ Utilize short wavelength
 - ✦ very large depth of focus
 - ✦ Synchrotron Light Source maintains energy anywhere from 10^6 to 10^9 eV

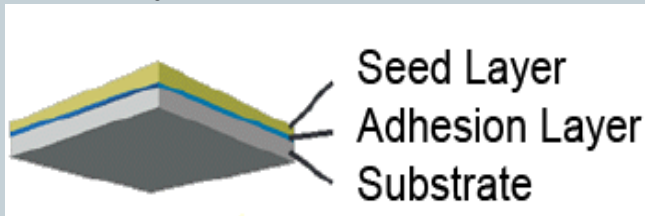


• Figure2: Synchrotron Light Source setup

Deep X-ray Lithography techniques



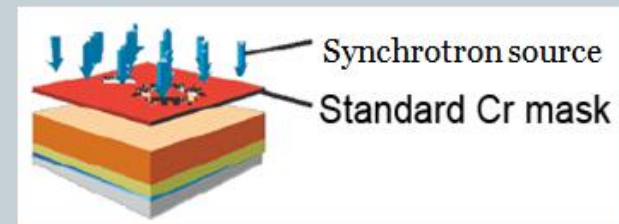
- Step 1:
 - Deposition of Adhesion
 - Seed layer



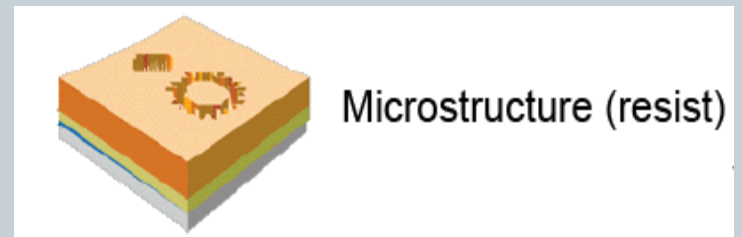
- Step 2:
 - resist coating



- Step 3:
 - expose the PMMA resist

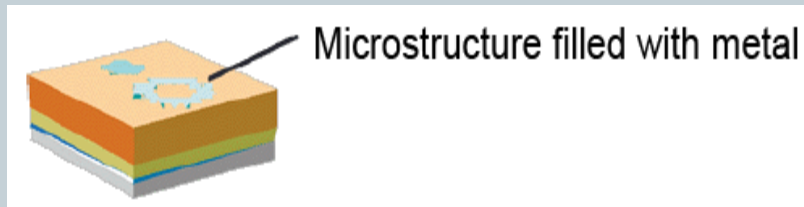


- Step 4:
-development of the exposed resist



Electroplating and Micro molding techniques

- Electroplating is a process to fill in the voids between the polymeric features.
- Step 5:
-metal plating

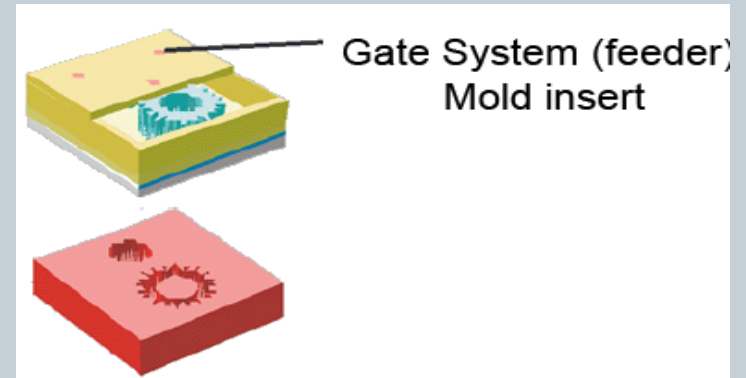


- Step 6:
-removal of the remaining resist



Molding is process of machining the overplated region filling the microstructure

- Step 7:



MORE about LIGA Technology

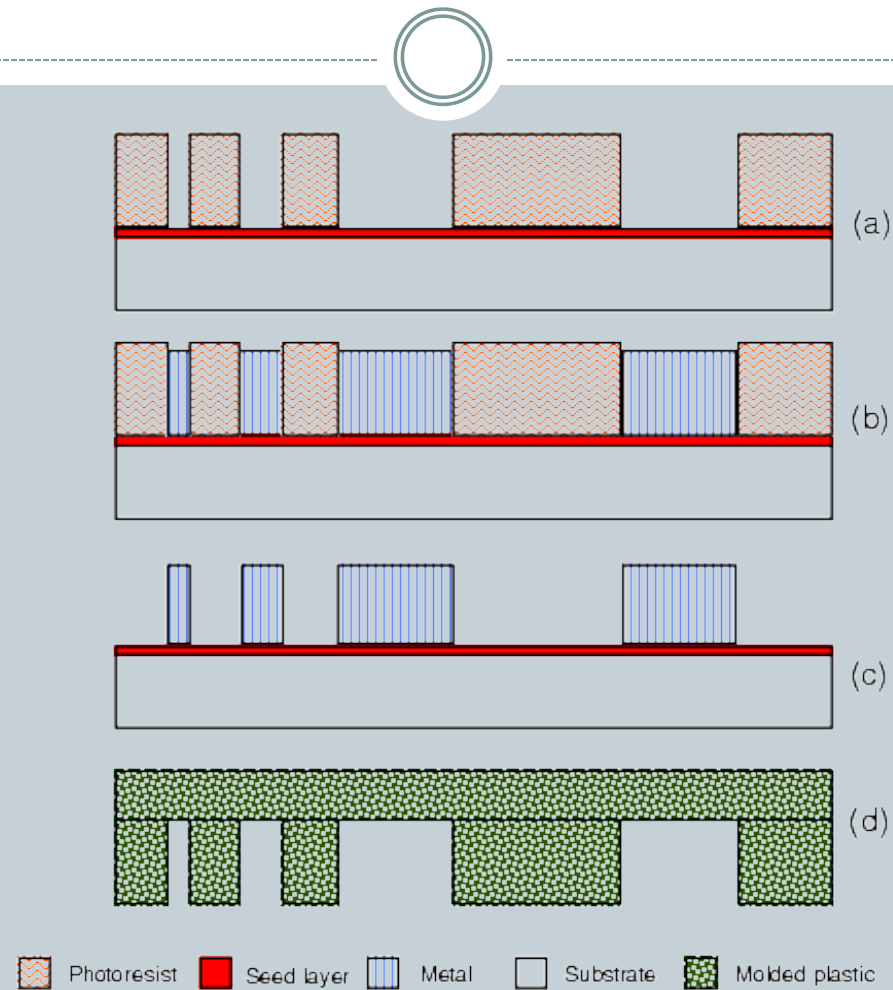


Fig. Outline of the LIGA technology. (a) Photoresist patterning, (b) electroplating of metal, (c) resist removal, and (d) molded plastic components.

Advantages & Disadvantage



- Large structural height and sidewall properties.
- Thickness ranging from 100-1000 μm .
- Spatial resolution.
- High aspect ratios.
- EUV LIGA is a cheaper alternative.

- X-ray LIGA is expensive due to the equipment required.
- Slow process.
- Complicated process.
- Difficulty transitioning from research to production.

Applications



- MEMS Components
- Sensors
- Actuators
- Trajectory Sensing Devices
- Mass Spectrometers
- Microoptical Components

Questions ?



References



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