LIGA Lithography

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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.
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 exciter 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

Figure 1: 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

- Figure 2: 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

  ![Microstructure filled with metal](image)

- **Step 6:**
  - removal of the remaining resist

  ![Microstructure (metal)](image)

- Molding is process of machining the overplated region filling the microstructure
- **Step 7:**

  ![Gate System (feeder) Mold insert](image)
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 & Disadvantages

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<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Large structural height and sidewall properties.</td>
<td>X-ray LIGA is expensive due to the equipment required.</td>
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<td>Thickness ranging from 100-1000 μm.</td>
<td>Slow process.</td>
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<td>Spatial resolution.</td>
<td>Complicated process.</td>
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<td>High aspect ratios.</td>
<td>Difficulty transitioning from research to production.</td>
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<td>EUV LIGA is a cheaper alternative.</td>
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Applications

- MEMS Components
- Sensors
- Actuators
- Trajectory Sensing Devices
- Mass Spectrometers
- Microoptical Components
Questions ?
References


