



FACULTY OF ENGINEERING AND
TECHNOLOGY
MEMS-035
Lecture -11

LIGA

LIGA is a German acronym for **L**ithographie, **G**alvanoformung, **A**bformung (Lithography, Electroplating, and Molding) that describes a fabrication technology used to create high-aspect-ratio microstructures.

The LIGA consists of three main processing steps; lithography, electroplating and molding. There are two main LIGA-fabrication technologies, **X-Ray LIGA**, which uses X-rays produced by a synchrotron to create high-aspect ratio structures, and **UV LIGA**, a more accessible method which uses ultraviolet light to create structures with relatively low aspect ratios.



The notable characteristics of X-ray LIGA-fabricated structures include:

- high aspect ratios on the order of 100:1
- parallel side walls with a flank angle on the order of 89.95°

smooth side walls with ≈ 10 nm, suitable for optical mirrors

structural heights from tens of micrometers to several millimeters

structural details on the order of micrometers over distances of centimeters

X-Ray LIGA

X-Ray LIGA is a fabrication process in microtechnology. LIGA was one of the first major techniques to allow on-demand manufacturing of high-aspect-ratio structures (structures that are much taller than wide) with lateral precision below one micrometer.

In the process, an X-ray sensitive polymer photoresist, typically PMMA, bonded to an electrically conductive substrate, is exposed to parallel beams of high-energy X-rays from a synchrotron radiation source through a mask partly covered with a strong X-ray absorbing material.

Chemical removal of exposed (or unexposed) photoresist results in a three-dimensional structure, which can be filled by the electrodeposition of metal. The resist is chemically stripped away to produce a metallic mold insert. The mold insert can be used to produce parts in polymers or ceramics through injection molding.



The LIGA technique's unique value is the precision obtained by the use of deep X-ray lithography (DXRL). The technique enables microstructures with high aspect ratios and high precision to be fabricated in a variety of materials (metals, plastics, and ceramics). Many of its practitioners and users are associated with or are located close to synchrotron facilities.

UV LIGA

UV LIGA utilizes an inexpensive ultraviolet light source, like a mercury lamp, to expose a polymer photoresist, typically SU-8. Because heating and transmittance are not an issue in optical masks, a simple chromium mask can be substituted for the technically sophisticated X-ray mask.

These reductions in complexity make UV LIGA much cheaper and more accessible than its X-ray counterpart. However, UV LIGA is not as effective at producing precision molds and is thus used when cost must be kept low and very high aspect ratios are not required.