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LIGA-15

MSE 621-01

Dr. Marc Madou

# Content

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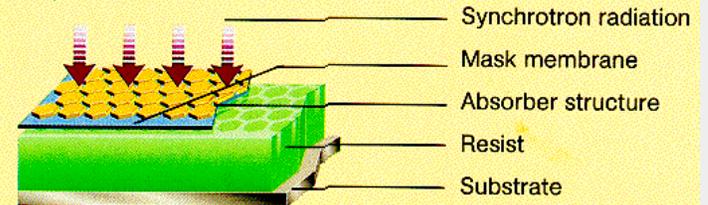
- ◆ **The LIGA process**
  - **Lithography**
  - **Electrodeposition**
  - **Molding**
- ◆ **Exposure station and mask**
- ◆ **Optimum X-ray radiation**
- ◆ **Electrodeposition**
- ◆ **Plastic molding**
- ◆ **LIGA applications**
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# The LIGA process

- ◆ **1st electroforming:**
  - **X-ray exposure (irradiation)**
  - **developing**
  - **electroforming for final metal product or for mold insert**

## X-ray deep-etch lithography and 1st electroforming

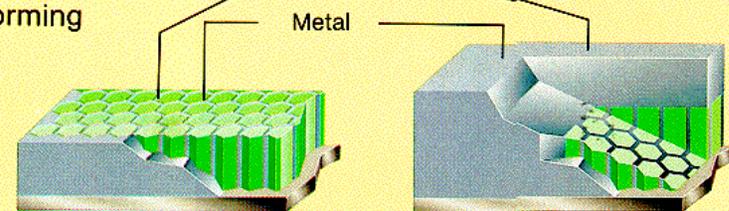
Irradiation



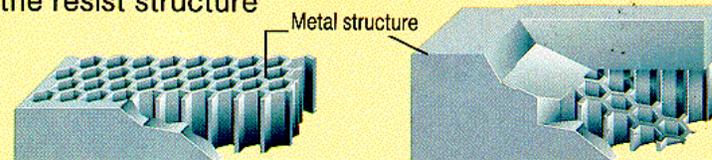
Developing



1st electroforming



Removal of the resist structure

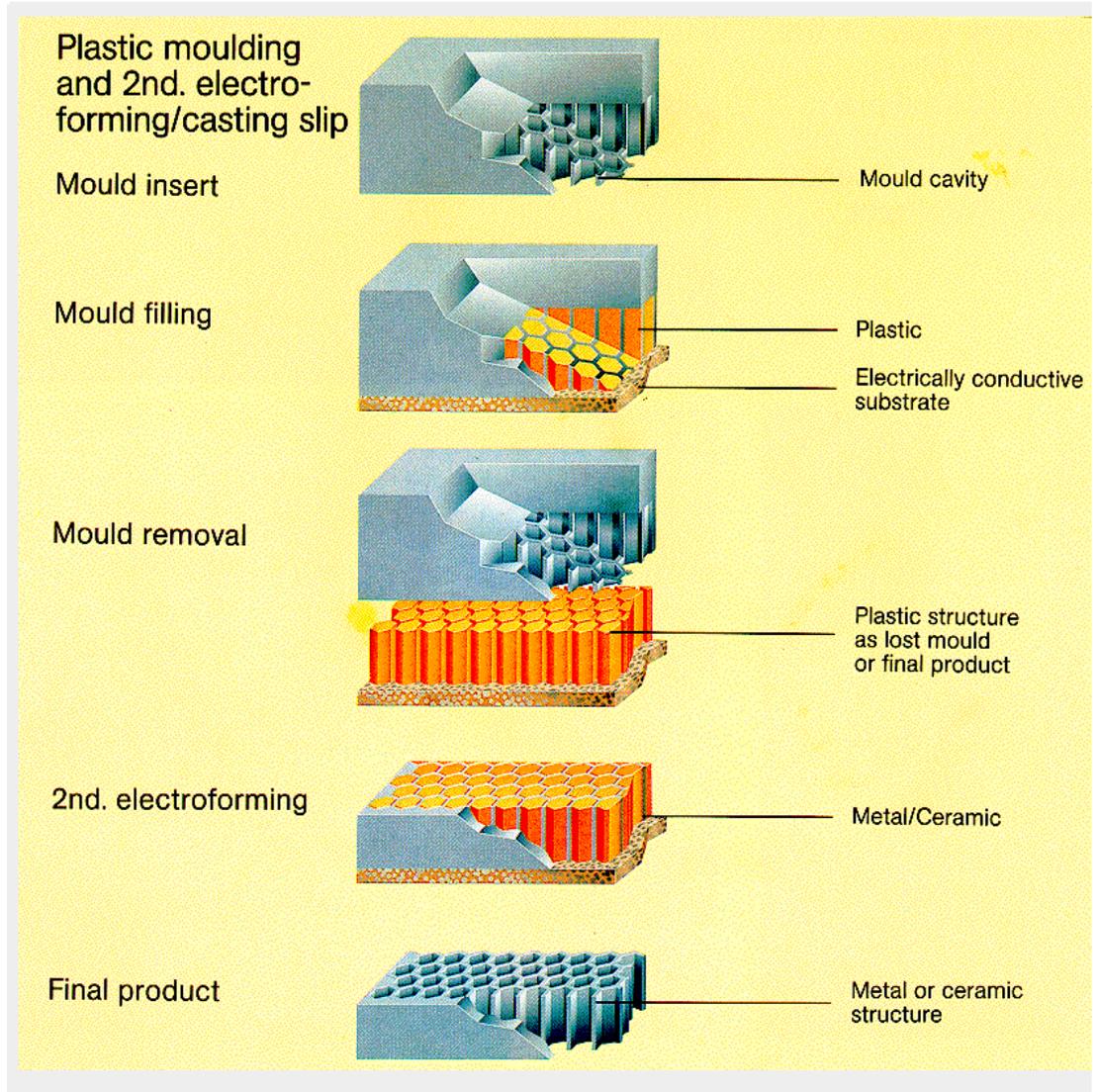


Final product

Mould insert

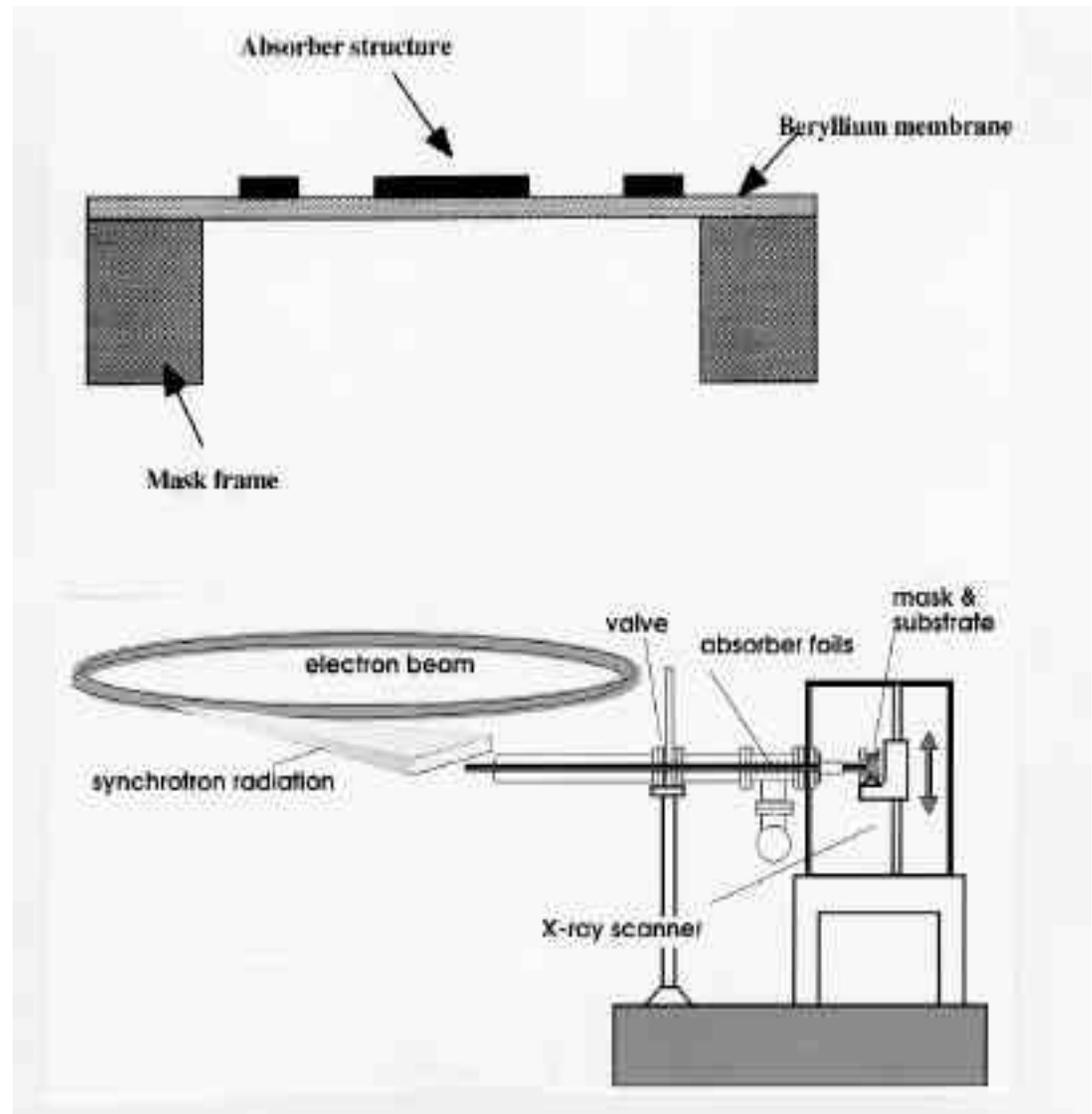
# The LIGA process

- ◆ **Plastic moulding and 2nd electroforming/casting slip**
  - **plastic final structures or lost mold**
  - **metal or ceramic final parts**



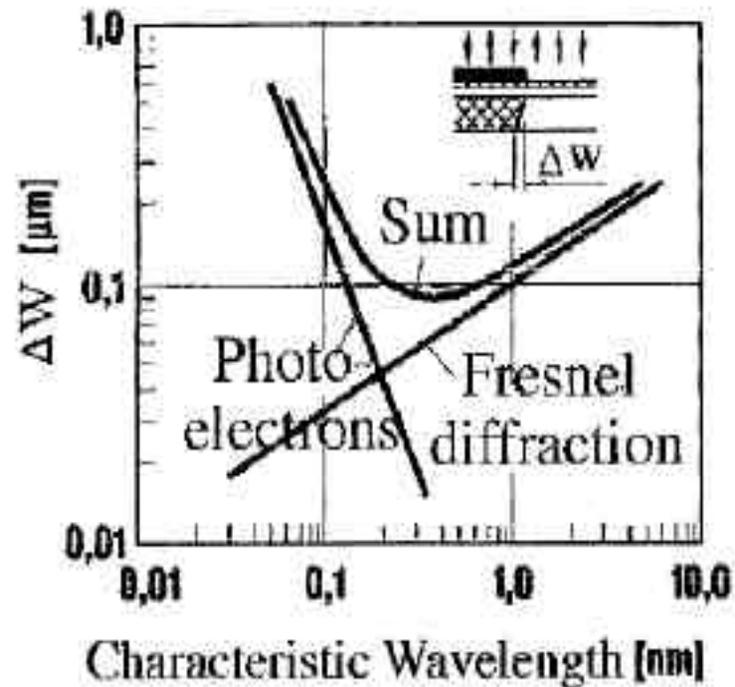
# Exposure station and masks

- ◆ **Mask :**
  - low Z membrane
  - high Z absorber
- ◆ **Alignment of substrate with mask is difficult since no visible light can pass through the mask membrane**
- ◆ **Sample is moved vertically through the irradiation band with a precision scanner**



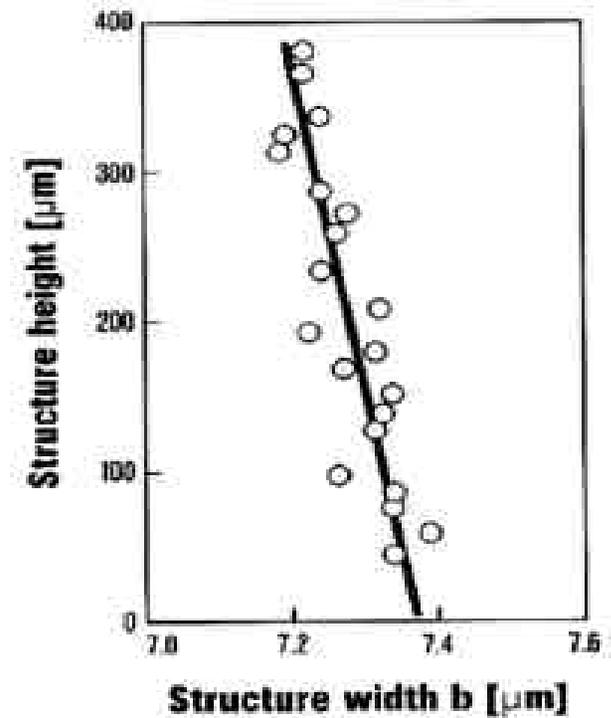
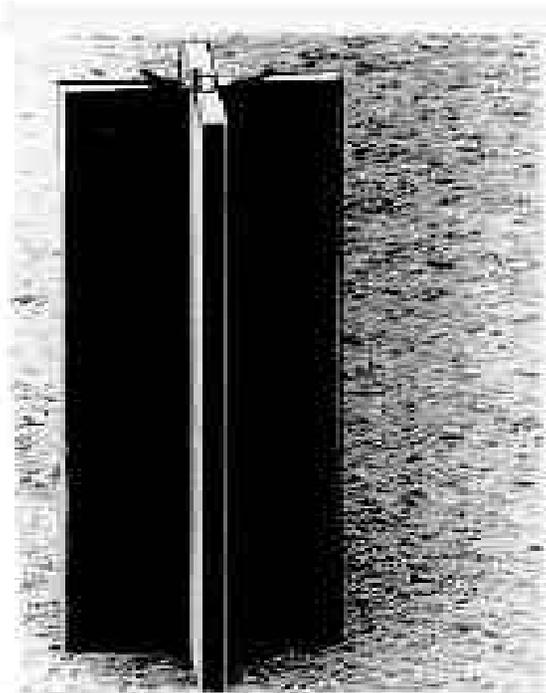
# Optimum X-ray radiation

- ◆ Optimum wavelength for optimum pattern transfer is 0.2 to 0.3 nm :
  - Diffraction increases as wavelength increases
  - Secondary electron emission increases as the wavelength decreases
- ◆ Variation in critical dimensions at this wavelength between the ends of a 500  $\mu\text{m}$  high structure is estimated at 0.2  $\mu\text{m}$



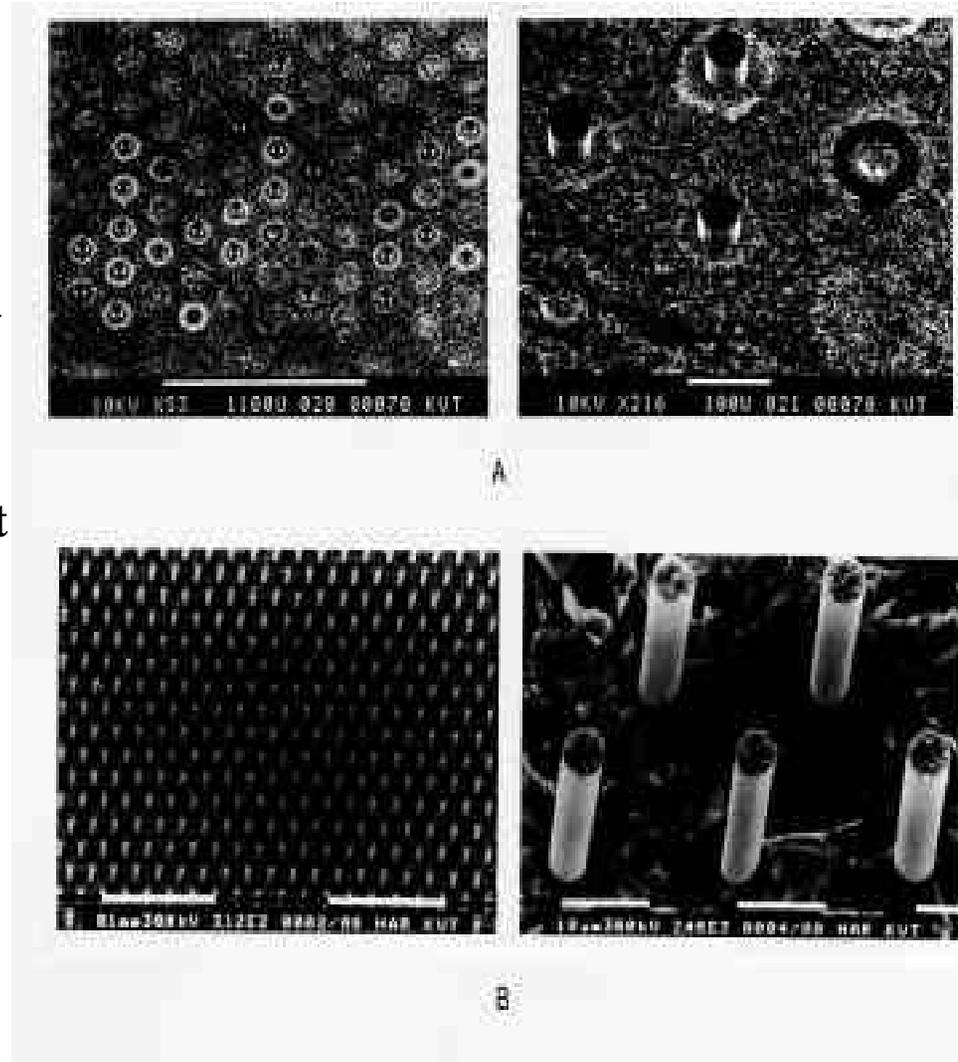
# Optimum X-ray radiation

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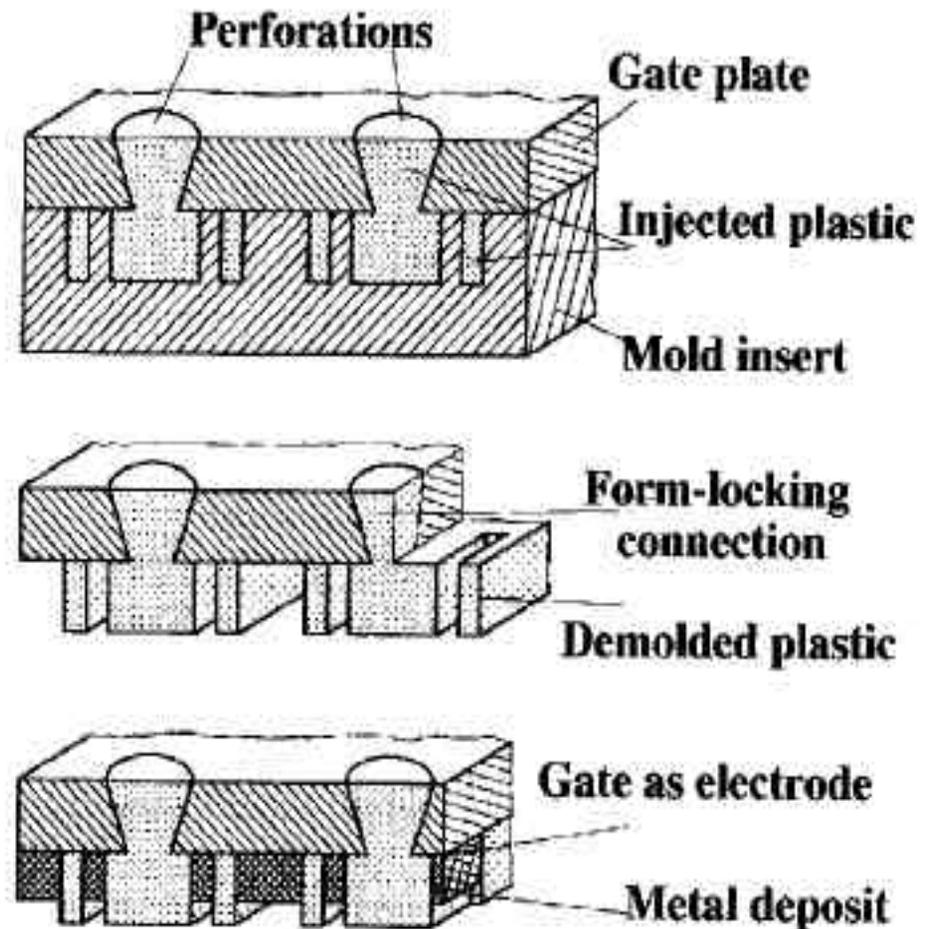
# Electrodeposition

- ◆ **Problems for plating in small plastic cavities:**
  - **Wetting agents must be added otherwise even 50  $\mu\text{m}$  posts do not plate**
  - **pH changes at the bottom of cavity**
  - **No agitation possible**
  - **In principle smaller features should plate faster but if the aspect ratio is too high they actually plate slower**



# Molding and demolding

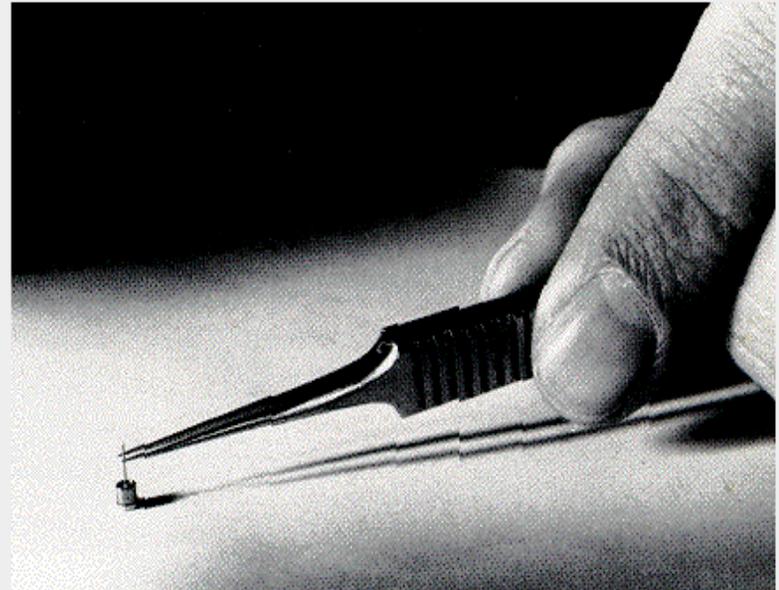
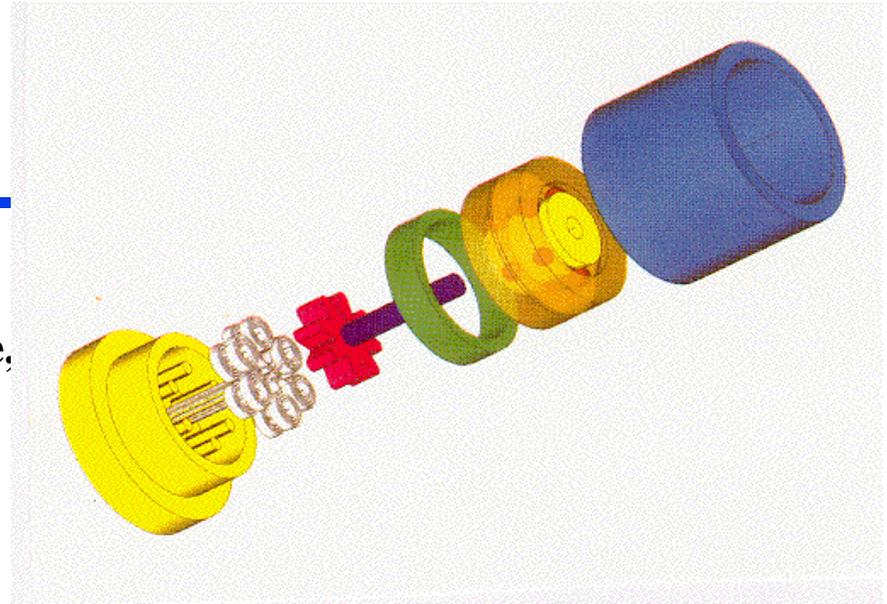
- ◆ **Reaction injection molding (RIM):**
  - Mixed reagents pumped into the mold
- ◆ **Injection molding:**
  - Mold is kept above the glass transition temperature and molten plastic is injected (e.g. CD's)
- ◆ **Compression molding (also hot embossing):**
  - A molding tool is pressed into the plastic material at temperatures above the glass transition temperature
- ◆ **Demolding requires extra smooth walls and internal mold release agents**



# LIGA applications

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- ◆ **Surface micromachining made motors with torques in the picoNm range possible, with LIGA  $10^{-6}$  to  $10^{-7}$  Nm are possible (more z-axis i.e. more torque)**
- ◆ **Combination of traditional and LIGA machining**



# LIGA applications

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- ◆ **Small Ni turbine**
- ◆ **Gas flow meter needs a cap**
- ◆ **Integrated fiber measures rotation speed**



# To read : Parts of Chapter 6

- ◆ **The LIGA process** p. 275-276
  - Lithography
  - Electrodeposition
  - Molding
- ◆ **Exposure station and mask** p. 279-283
- ◆ **Optimum X-ray radiation** p. 289
- ◆ **Electrodeposition** p. 292
- ◆ **Plastic molding** p. 298-302
- ◆ **LIGA applications** p. 306 (turbine)  
and p. 317 (micromotor)