Micro-maquinado

Hernán Pastoriza

Laboratorio de Bajas Temperaturas
Centro Atómico Bariloche
&
Instituto Balseiro

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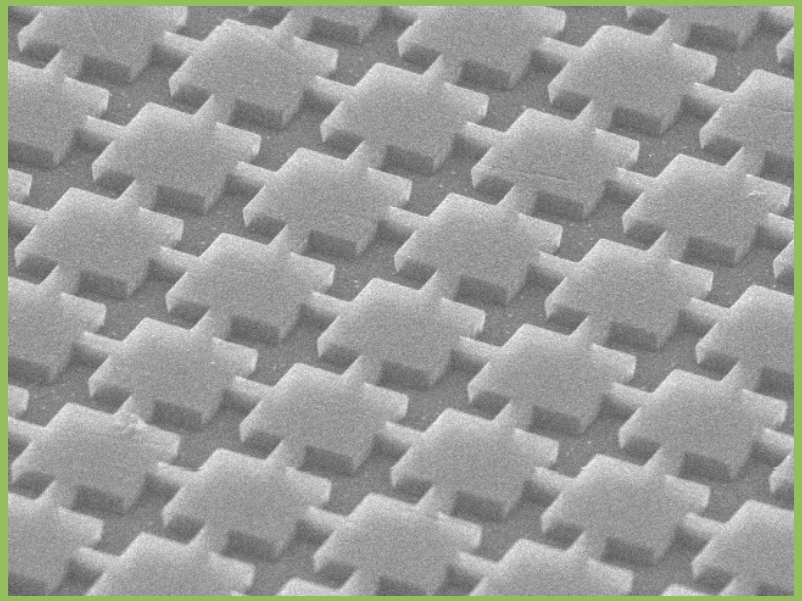
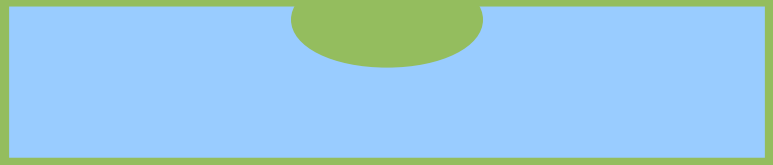
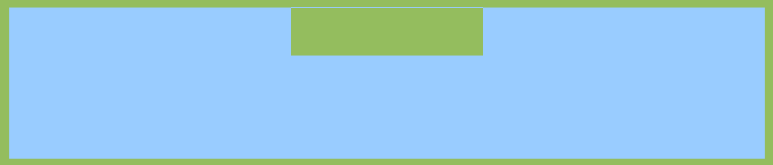


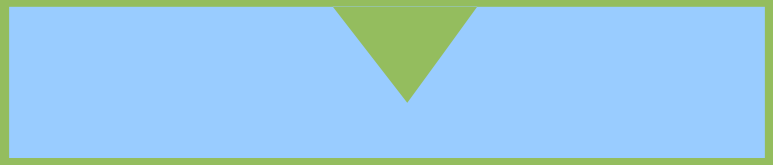
1) Transferir la topografía al sustrato



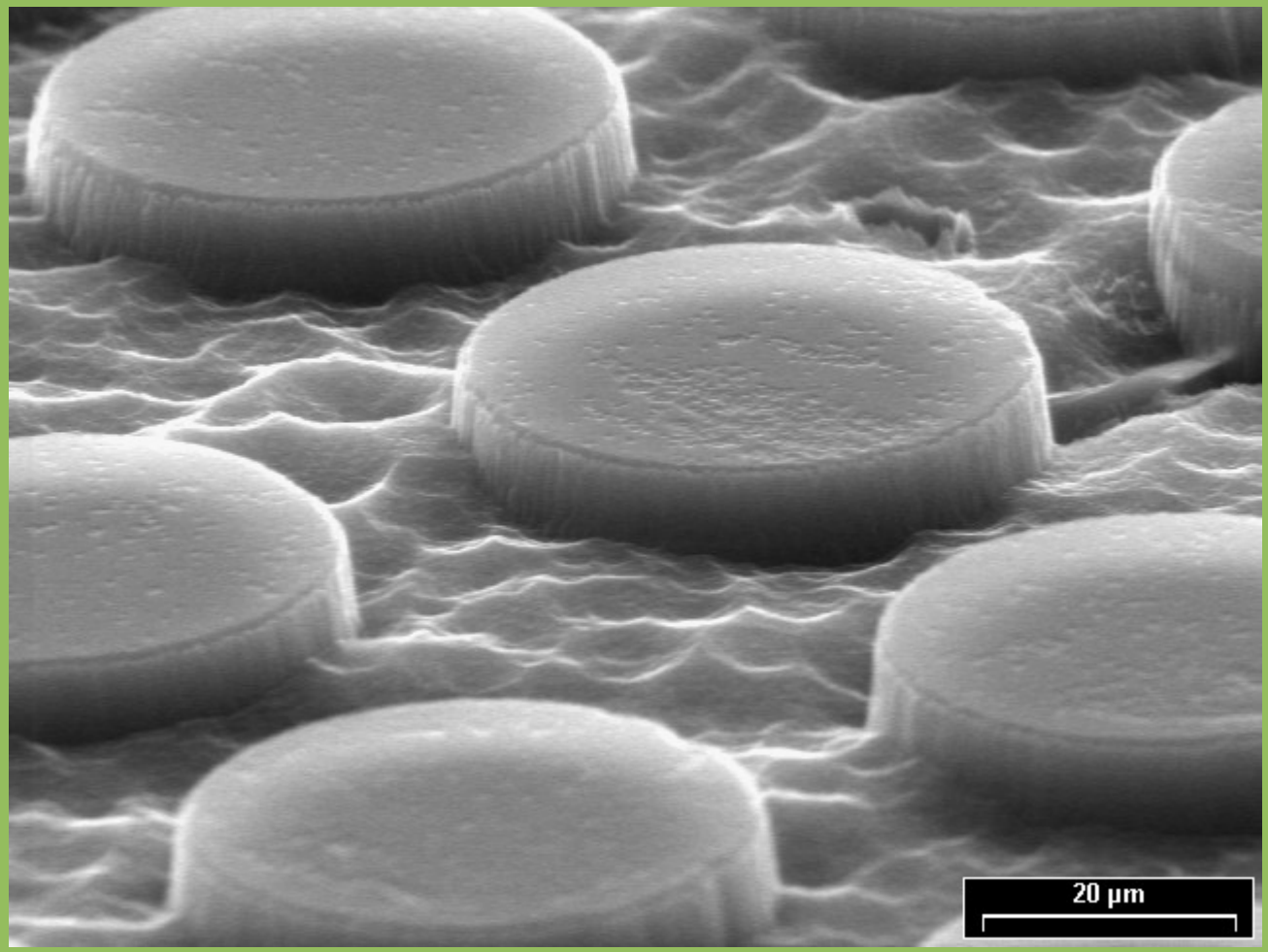
Ataque isotrópico



Ataque aniisotrópico



Ataque anisotrópico
x ejes cristalograficos



Sustrato: Monocristal de $Bi_2Sr_2CaCu_2O_8$
Ataque con Iones de Ar 5keV

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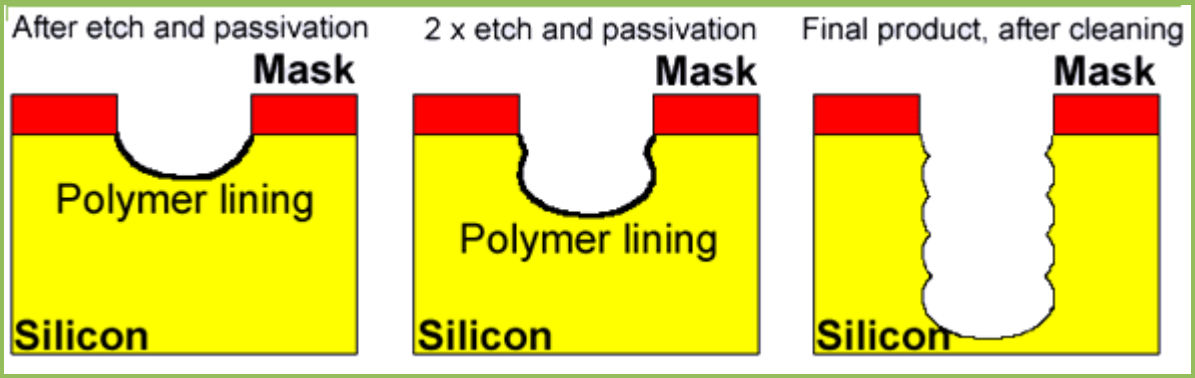
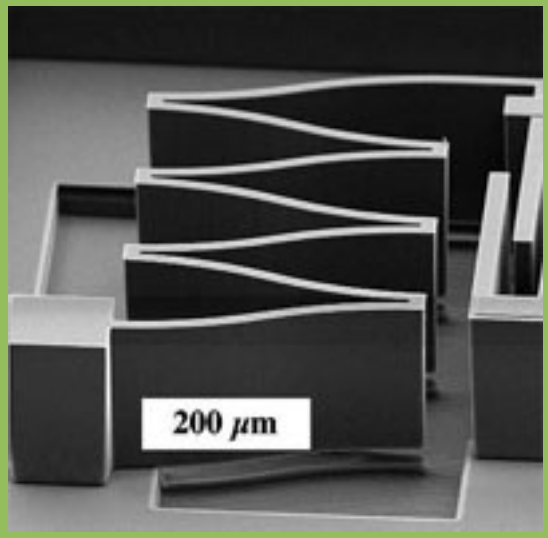
Ataque seco: Reactive Ion Etching





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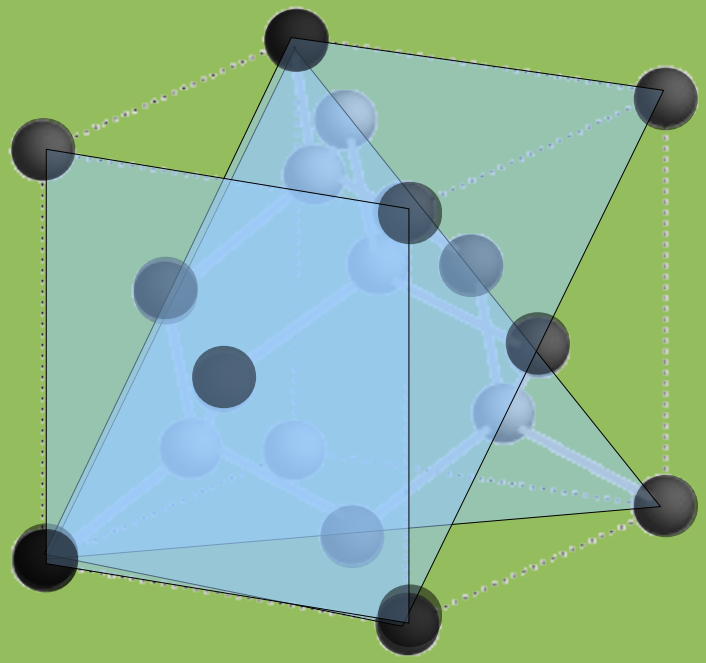
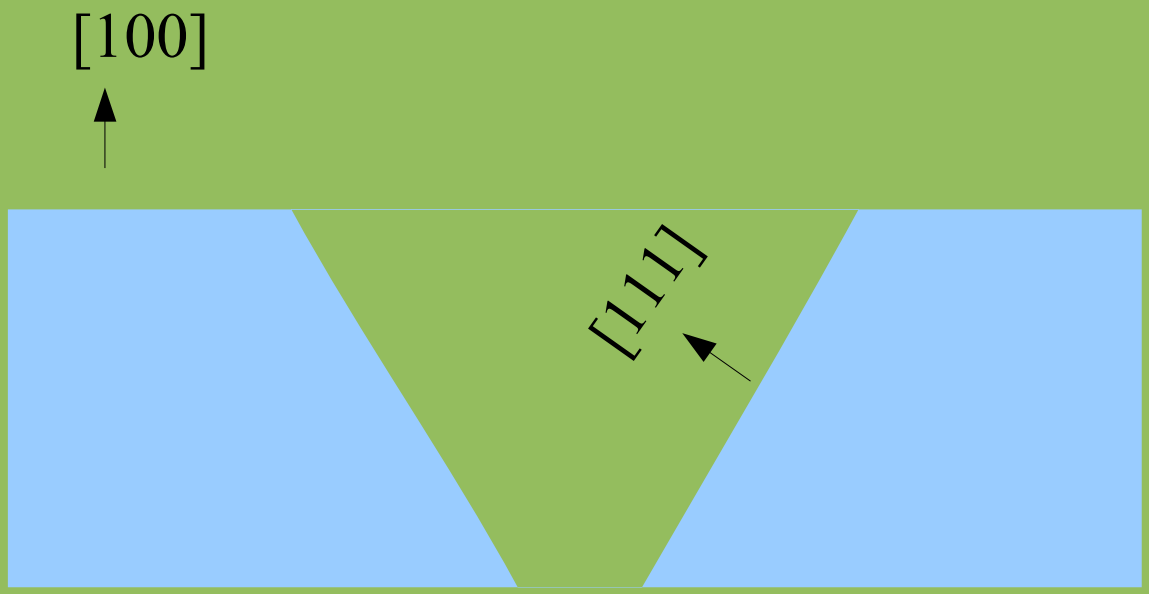
{100}

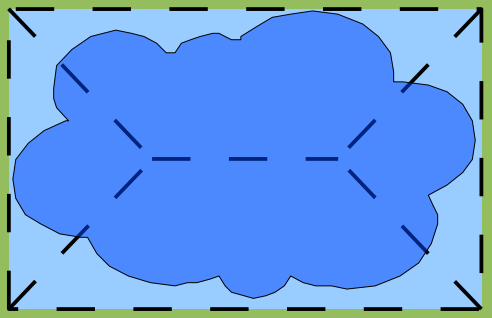
{110}

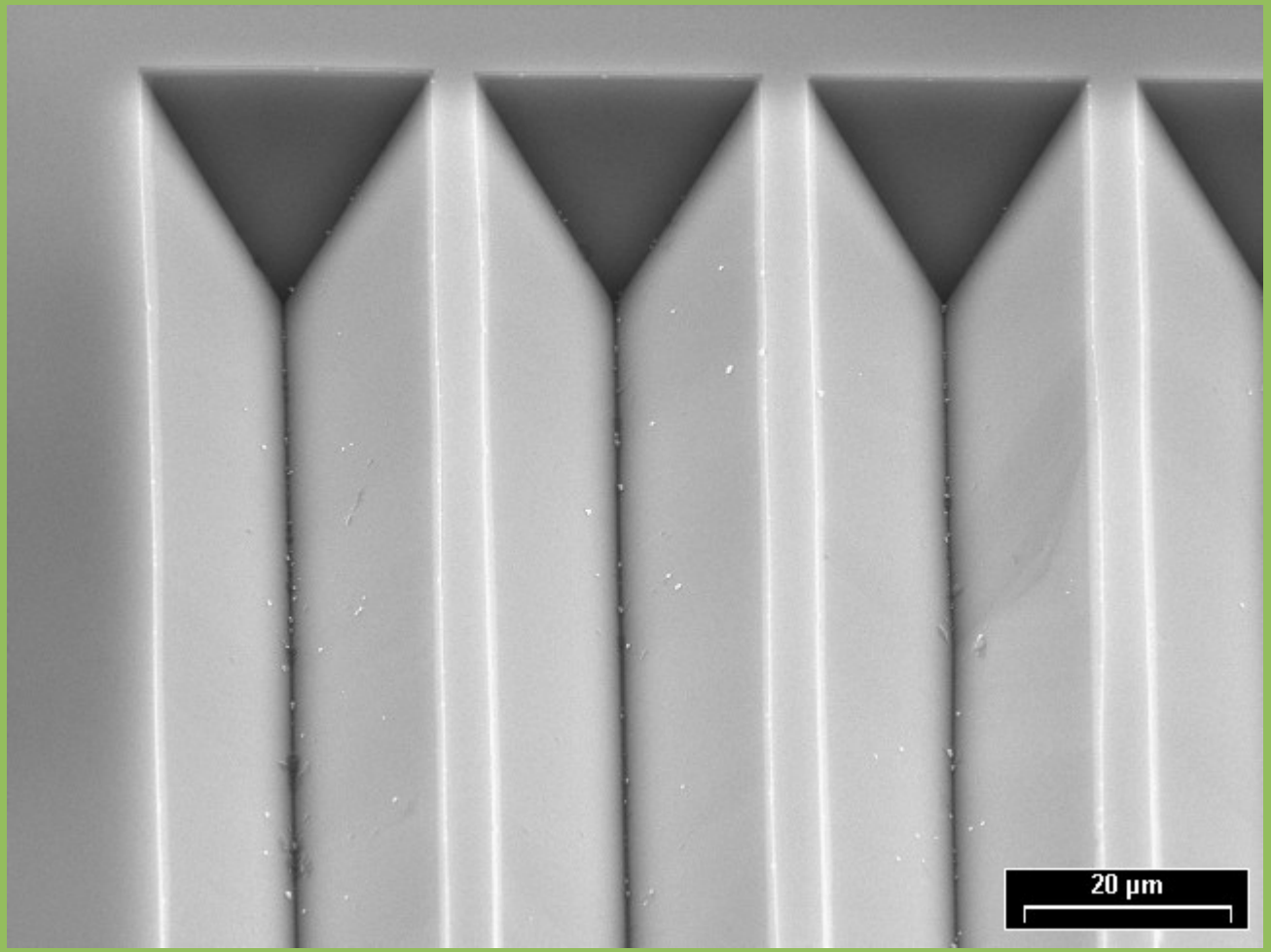
{111}





KOH
(hidróxido de
Potasio)





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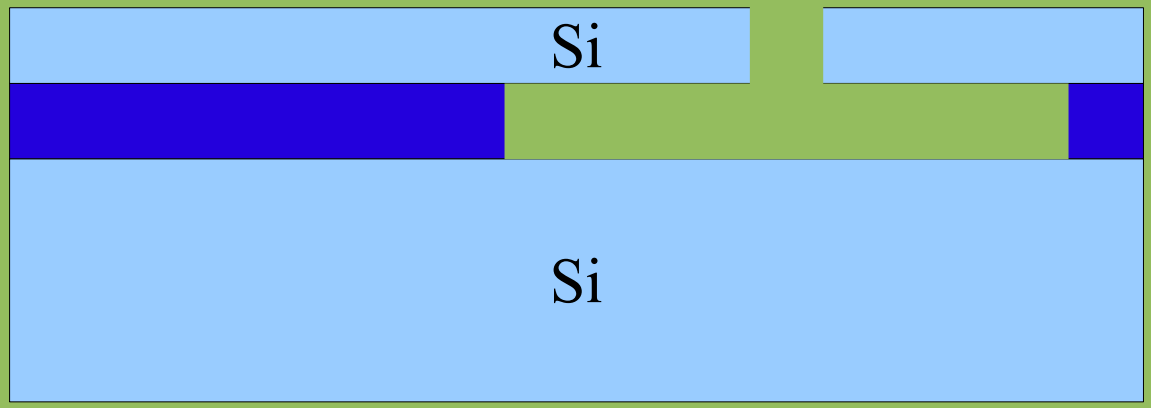
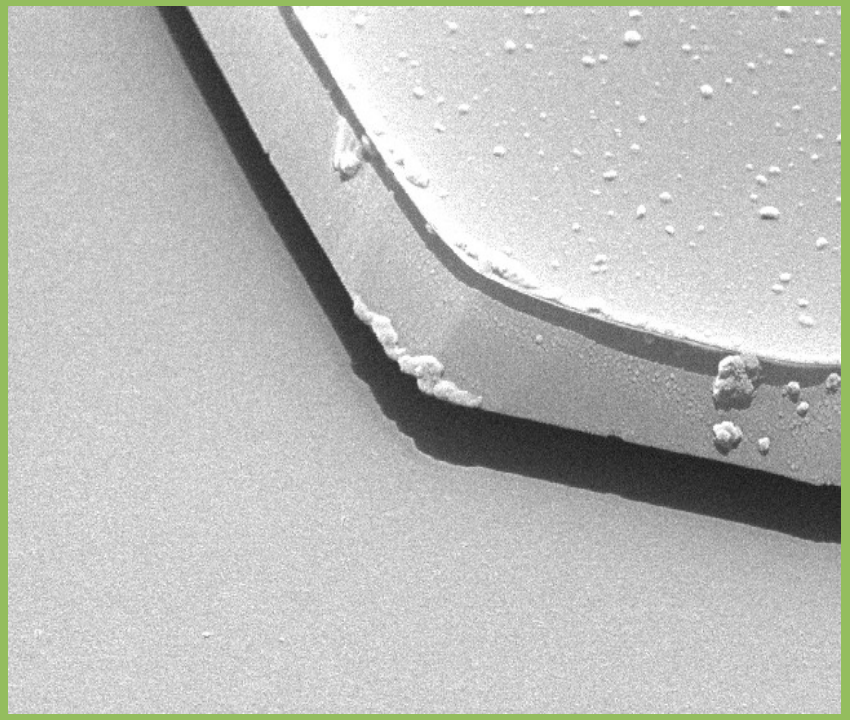
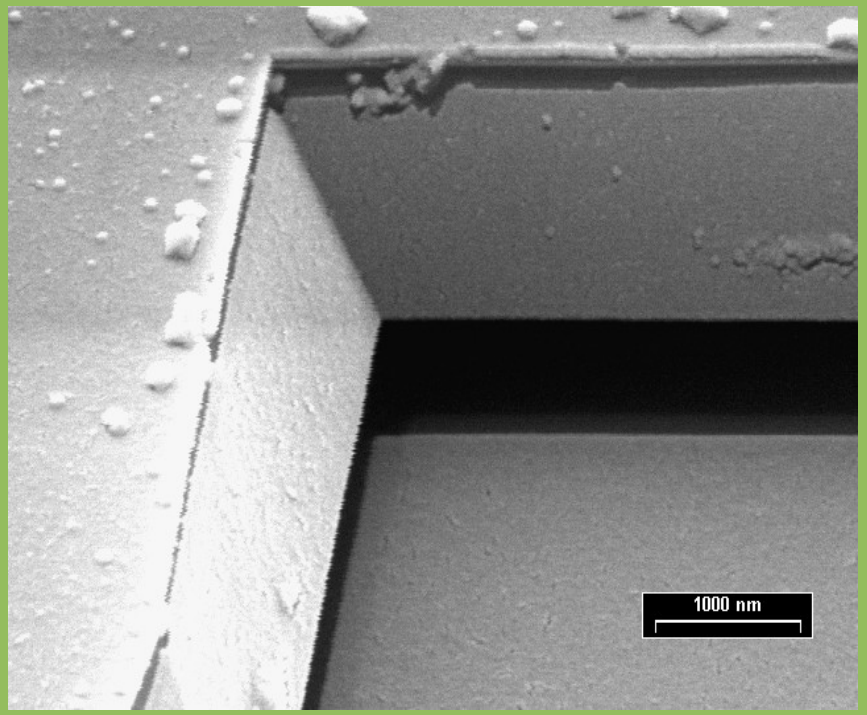
Bulk micro-machining:

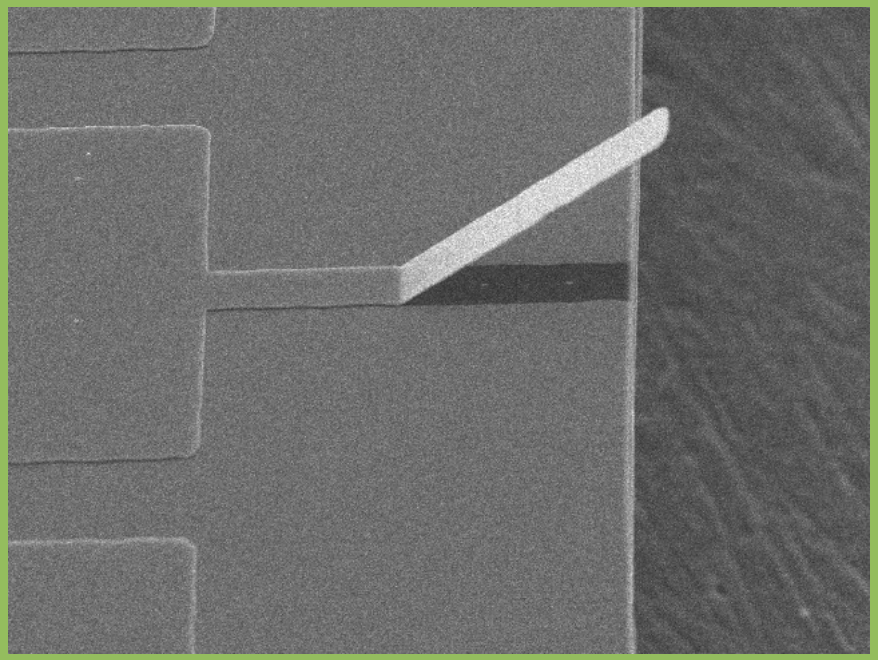
La parte estructural consiste en lo que queda despues de haber removido parte del sustrato

Sustratos SOI (Silicon on Insulator)









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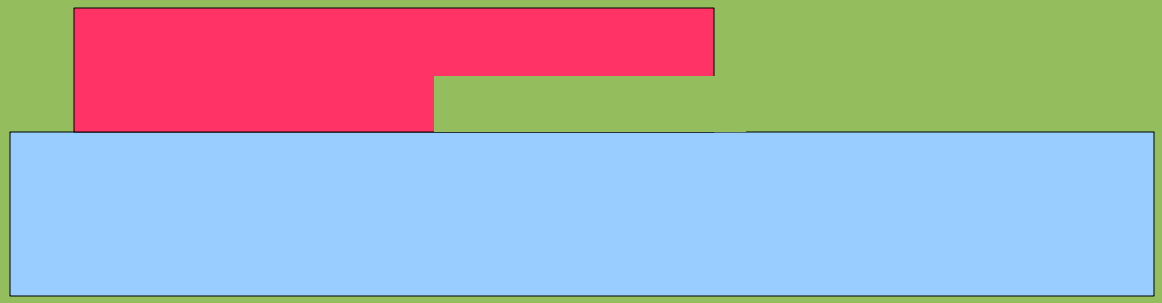
Surface micro-machining:

Los componentes estructurales son obtenidos por deposición



Foundry MEMSCAP

MUMP (Multi User MEMS Process)

PolyMUMPS:
Componente estructural Silicio Policristalino
Componente de sacrificio: Dióxido de Silicio

U$4600 x cm² (U$3200 Académico)

Deposición Nitruro de Silicio (SiN_x)

Deposición Poly0 (Silicio Policristalino)

Primera etapa de litografía (Máscara Poly0)

Remoción del Poly0 no protegido mediante Reactive Ion Etching

Deposición del Óxido de Silicio 1 mediante LPCVD

2da etapa de litografía (Máscara Dimple)

Seguido de un RIE

3ra etapa de litografía (Máscara Anchor 1)

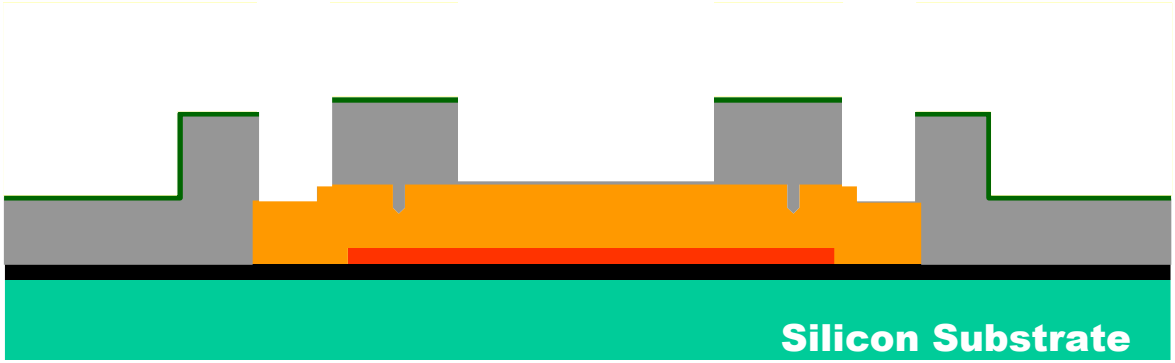
Y otra vez RIE (más tiempo)

Deposición de polysilicon (Poly1) using LPCVD...

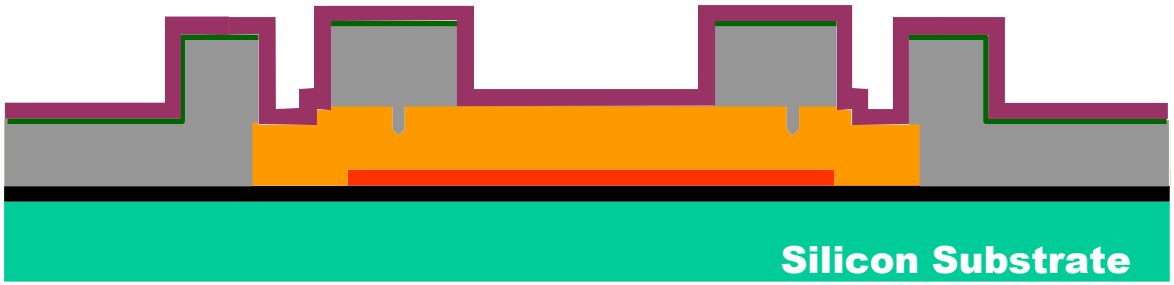
Seguido de una deposición de PSG (Phospho-silicate-glass) y recocido

4ta etapa de litografía (Máscara Poly1)

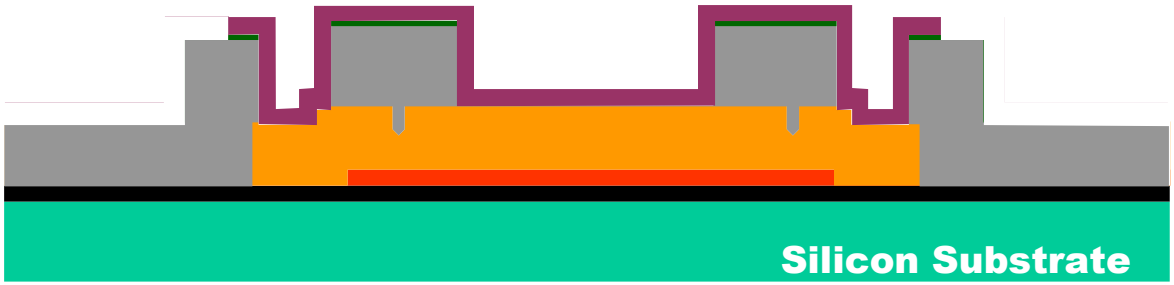
Y otra vez RIE



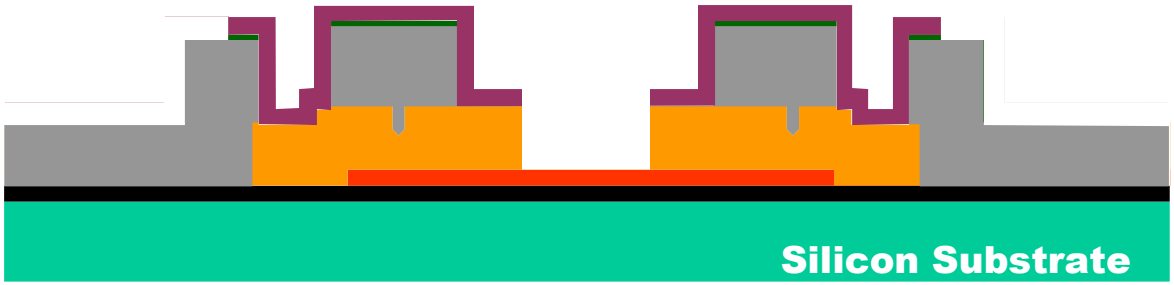
Deposición del 2do Óxido



5ta etapa de litografía (Máscara Poly1_Poly2_VIA) y ... RIE

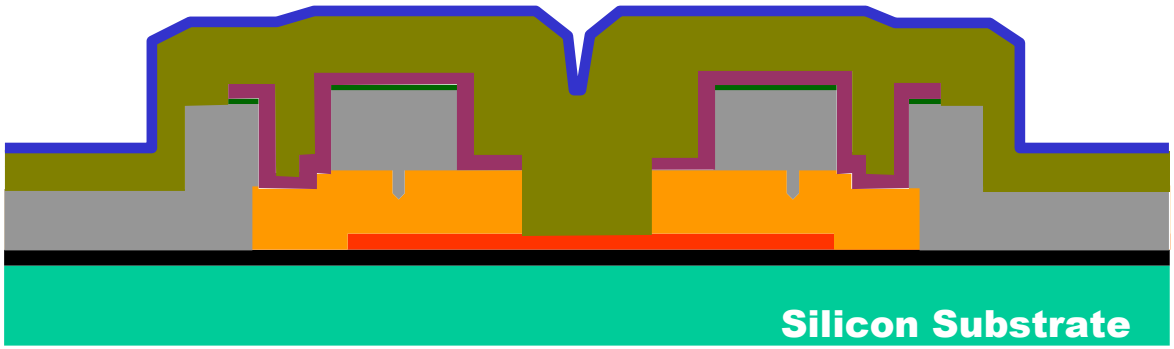


6ta etapa de litografía (Máscara Anchor 2) + RIE



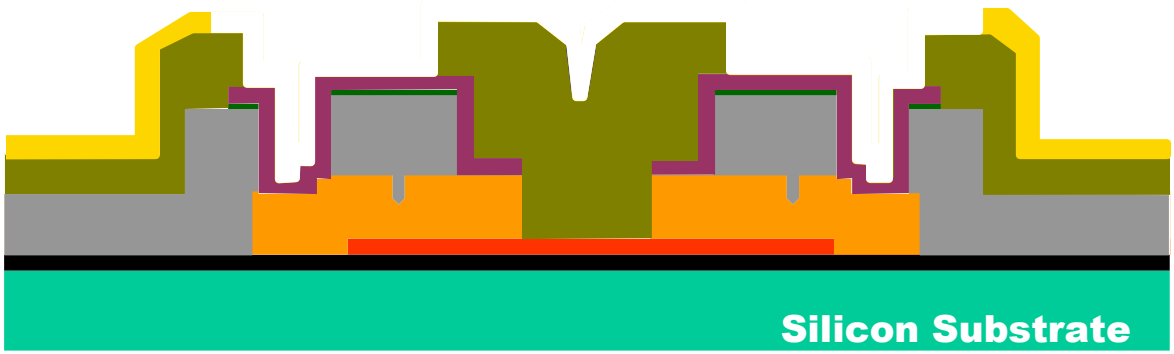
Deposición de polysilicon (Poly2) using LPCVD...

Seguido de una deposición de PSG (Phospho-silicate-glass) y recocido



7ma etapa de litografía (Máscara Poly2) y RIE

8va etapa de litografía (Mascara Metal) y Lift-off



Disolver los Óxidos en HF

Material Layer	Thickness (µm)	CD Tolerances	Lithography Level Name
Nitride	0.6	--	--
Poly 0	0.5	1.800 to 2.200 um Lines	POLY0 (HOLE0)
First Oxide	2.0	1.800 to 2.200 um Spaces 1.700 to 2.300 um Spaces	DIMPLE ANCHOR1
Poly 1	2.0	1.750 to 2.250 um Lines	POLY1 (HOLE1)
Second Oxide	0.75	1.750 to 2.250 um Spaces 1.750 to 2.250 um Spaces	POLY1_POLY2_VIA ANCHOR2
Poly 2	1.5	1.700 to 2.300 um Lines	POLY2 (HOLE2)
Metal	0.5	2.500 to 3.500 um Lines	METAL (HOLEM)

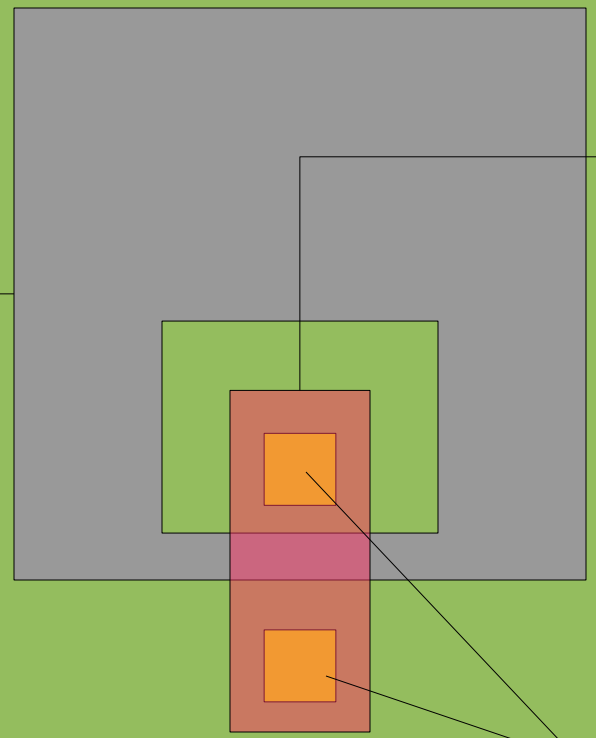
Mnemonic level name	Actual Feature Drawn	CIF level name	GDS level number	Nominal line/space	Minimum feature	Minimum spacing
*POLY0	Poly line	CPZ	13	3.0	2.0	2.0
*DIMPLE	Dimple hole	COS	50	3.0	2.0 spaces 3.0 holes	3.0
*ANCHOR1	Oxide hole	COF	43	3.0	3.0	2.0
*POLY1	Poly line	CPS	45	3.0	2.0	2.0 / 2.5[1]
*POLY1_POLY2_VIA	Via hole	COT	47	3.0	2.0 spaces 3.0 holes	2.0
*ANCHOR2	Anchor hole	COL	52	3.0	3.0	2.0
*POLY2	Poly line	CPT	49	3.0	2.0	2.0 / 2.5[1]
*METAL	Metal line	CCM	51	3.0	3.0	3.0
*HOLE0	Hole	CHZ	41	3.0	2.0	2.0
*HOLE1	Hole	CHO	0	4.0	3.0	3.0
*HOLE2	Hole	CHT	1	4.0	3.0	3.0
*HOLEM	Hole	CHM	48	5.0	4.0	4.0

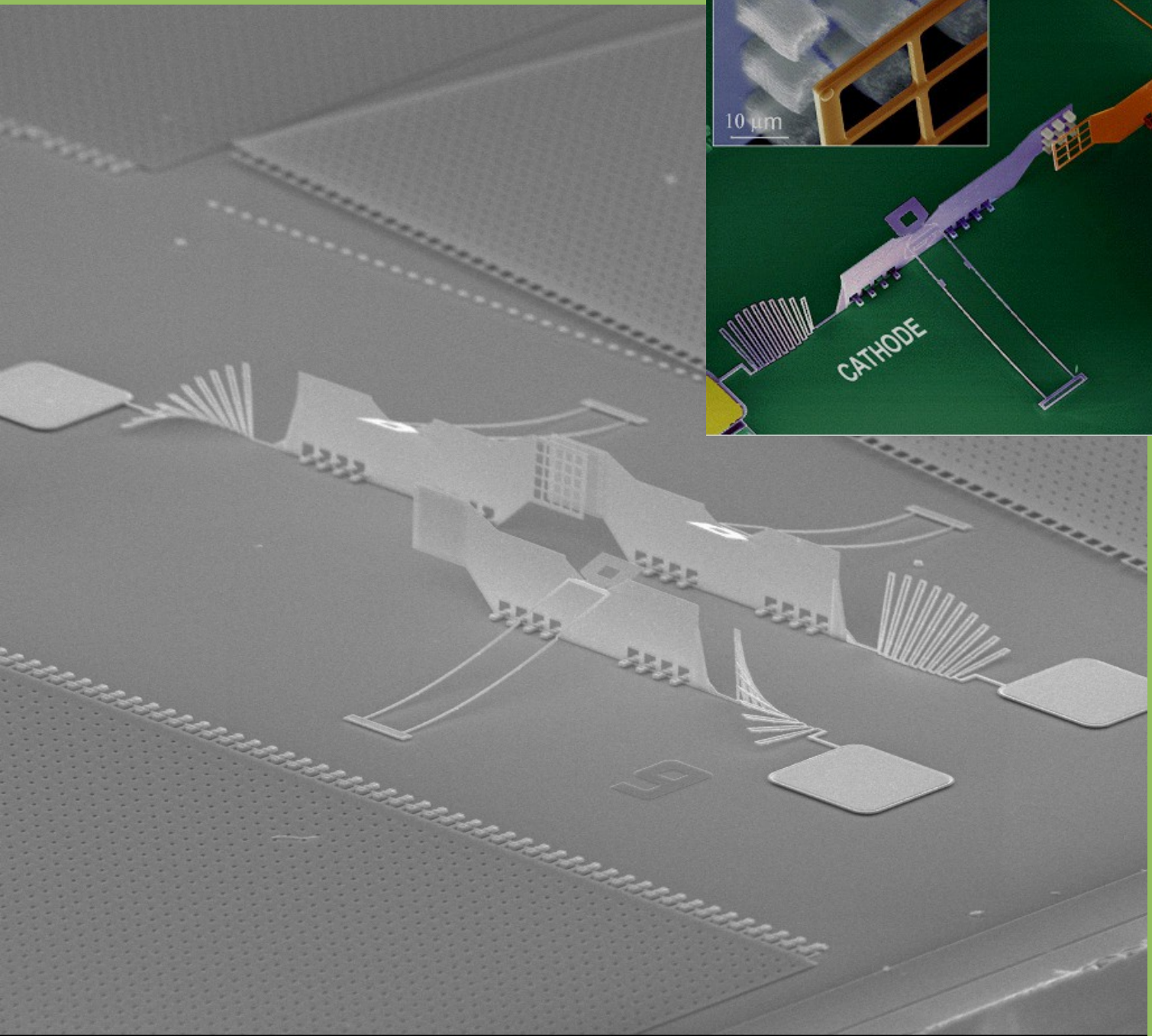
Reglas.

Rule	Rule Letter	Figure #	Min. Value (µm)
POLY1 enclose ANCHOR1	G	2.6	4.0
POLY1 enclose DIMPLE	N	2.13	4.0
POLY1 enclose POLY1_POLY2_VIA	H	2.9, 2.11	4.0
POLY1 enclose POLY2	O	2.14	4.0
POLY1 space to ANCHOR2	K	2.11	3.0
***Lateral etch holes space in POLY1**	**R**	**2.15**	**≤30 (max. value)**

Rule	Rule Letter	Figure #	Min. Value (µm)
POLY2 enclose ANCHOR2	J	2.7,2.10	5.0
POLY2 enclose POLY1_POLY2_VIA	L	2.9	4.0
POLY2 cut-in POLY1	P	2.14	5.0
POLY2 cut-out POLY1	Q	2.14	4.0
POLY2 enclose METAL	M	2.12	3.0
POLY2 space to POLY1	I	2.10	3.0
HOLE2 enclose HOLE1	T	2.16	2.0
HOLEM enclose HOLE2	U	2.16	2.0
***Lateral etch holes space in POLY2**	**S**	**2.15**	**≤30 (max. value)**

Por ejemplo
una bisagra:





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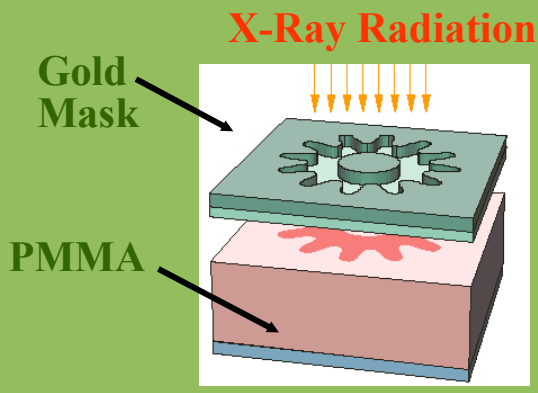
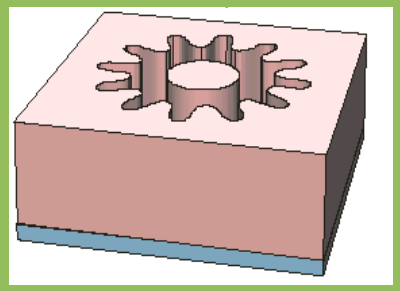
LIGA Nickel High Aspect Ratio (HAR) Micromachining

(Lithographie, Galvanoformung, Abformung (LIGA))

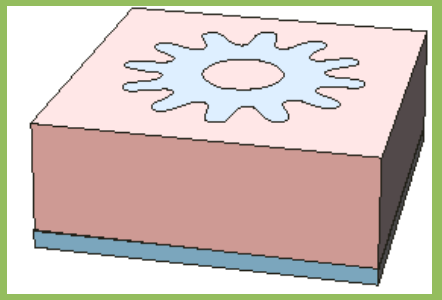
E. W. Becker etal.,),” Microelectron. Eng., vol. 4, pp. 35–36, 1986.



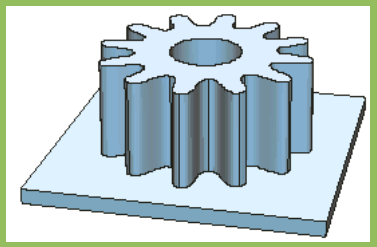
1. Expose PMMA to **Synchrotron radiation**



2. Develop PMMA into mold



1. Electroplate into mold and remove mold material.–



Feature lengths and widths as small as 20um

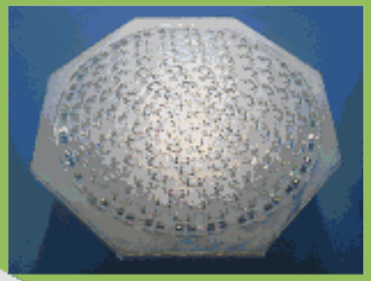
Feature heights are from 200-300um

Aspect Ratios > 10

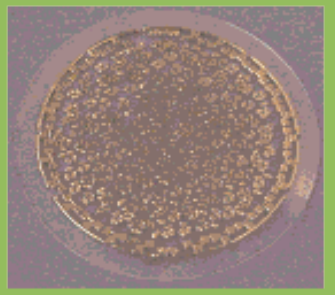
LIGA Process

Mask Layout & Fabrication

Substrate Prep



X-Ray Expose/Dev



Electroplating

Planarization