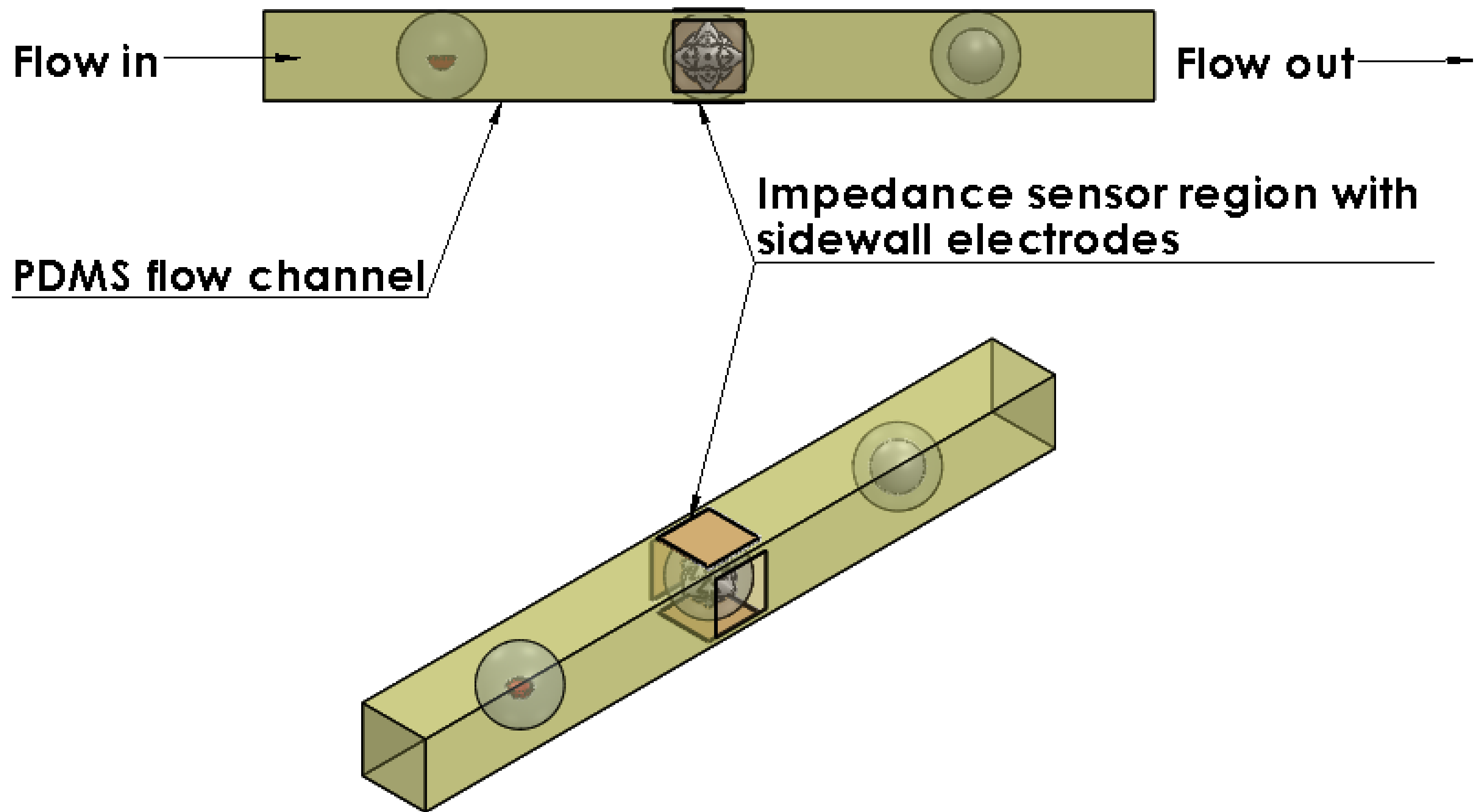
Project: Characterize Innotec for Sidewall Electrodes Using Shadow Mask

Shane Crippen

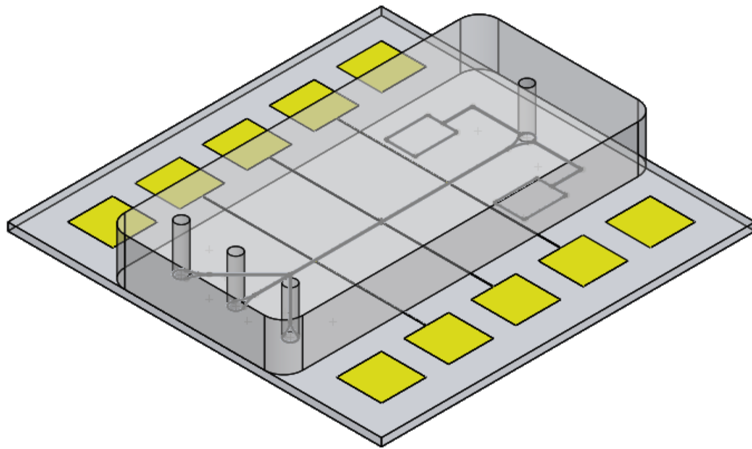
J Provine (mentor)

Goal: Characterize Innotec metal deposition on PDMS sidewalls using shadow mask technique

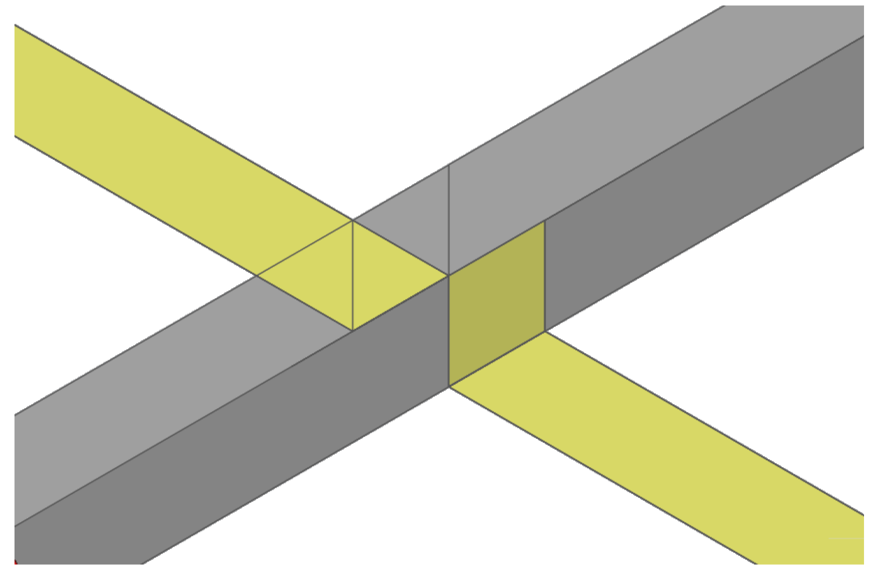


Goal: Characterize Innotec metal deposition on PDMS sidewalls using shadow mask technique

General Chip Layout



Closeup Sidewall Electrodes



Angle jig for Innotec

Document jig design & principle of operation

Jig in planetary

Jig angle "gauge"

Innotec is an e-beam metal evaporation system with a 22, 4" wafer planetary retrofitted with a single wafer jig allowing wafer alignment at angles to normal.

Parameter & metrics

Parameters

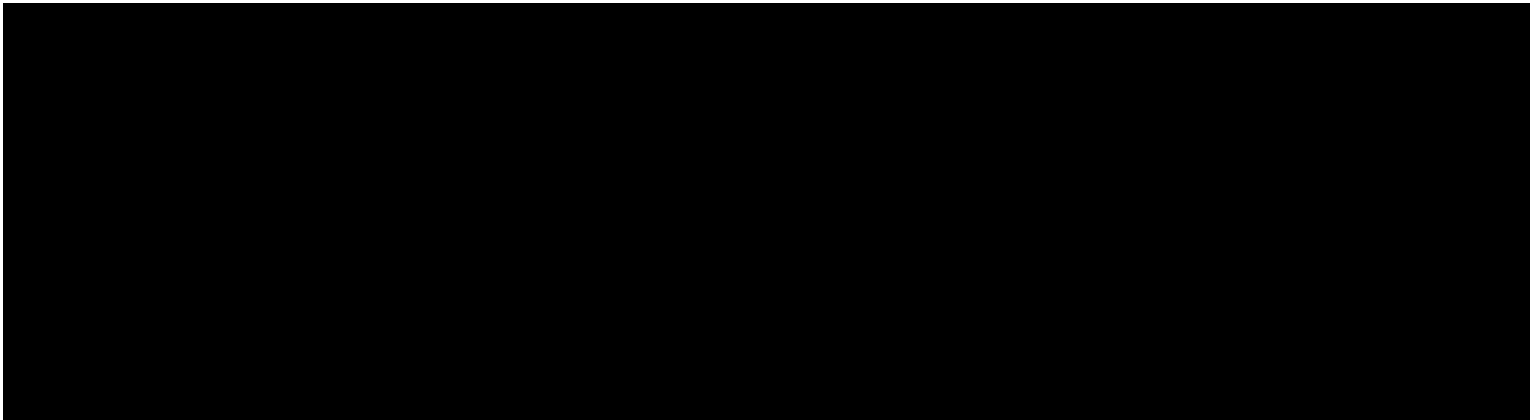
- Metal
  - Gold with possible Ti adhesion layer
- Substrates
  - PDMS & silicon
  - Silicon as a control
- Aspect ratio
  - 1:1 (width:height)
- Film width & thickness

Metrics

- Microstrip alignment accuracy
  - Aligning shadowmask to PDMS channels
  - Aligning the above to the jig
    - Tilt and rotation
- Microstrip "robustness"
  - Film width & thickness
- Microstrip resistance
  - Film width & thickness

Timeline

- Project statistics
  - 6 Phases
  - 109 subtasks
  - 46 days
- Assumptions
  - Timely equipment training
  - Availability of equipment reservations
  - Minimal equipment down time
  - Sanity



Innotec reservations

7 days out

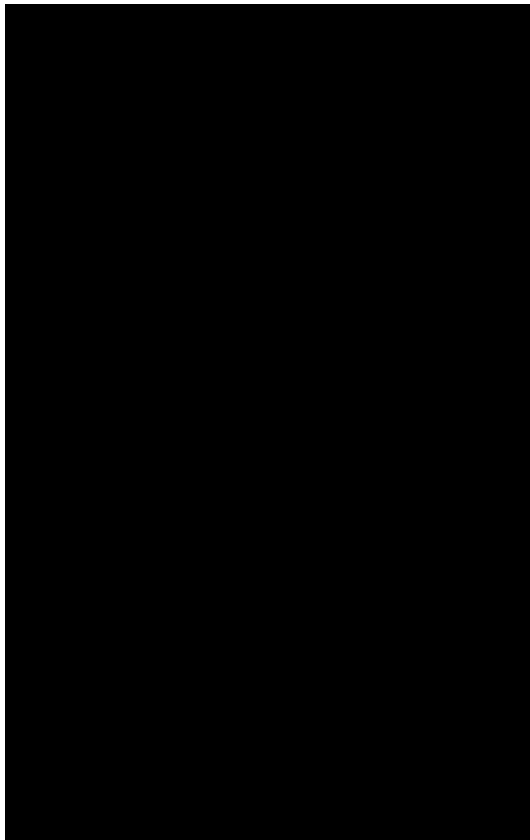
Mon, OCT 17	Tue, OCT 18	Wed, OCT 19	Thu, OCT 20	Fri, OCT 21	Sat, OCT 22	Sun, OCT 23	Mon, OCT 24
	jasonlin	tazryu78	jasonlin	lennonl	hongyuc	tanemura	jweisse
	jasonlin	tazryu78	jasonlin	lennonl	hongyuc	tanemura	jasonlin
	jasonlin	tazryu78	jasonlin	tanemura	hongyuc	tanemura	jasonlin
	jasonlin	jweisse	jasonlin	tanemura	jasonlin	tanemura	kcbalram
tkodama	tkodama	jweisse	jweisse	tanemura	jasonlin		kcbalram
tkodama	tkodama	jweisse	jweisse	tanemura	jasonlin		kcbalram
tkodama	ywidjaja	jweisse	jweisse	yoonjin	kcbalram	kcbalram	kcbalram
	ywidjaja		jweisse	yoonjin	kcbalram	kcbalram	
	ywidjaja			yoonjin	kcbalram	kcbalram	
	ywidjaja			yoonjin	kcbalram	kcbalram	
	dkozak		zguo		ywidjaja	ywidjaja	
	dkozak		zguo		ywidjaja	ywidjaja	
	dkozak	kleedle	zguo	justinwu	ywidjaja	ywidjaja	
	dkozak	kleedle	zguo	justinwu	ywidjaja	ywidjaja	
	dkozak	kleedle	usha	justinwu	zguo		
	dkozak	kleedle	usha	justinwu	zguo		
jperez	haiwei	horvath	usha	justinwu	zguo		jperez
jperez	haiwei	horvath	usha	justinwu	zguo		jperez
jperez	haiwei	horvath	ytcheng	helencxy			jperez
jperez	haiwei	horvath	ytcheng	helencxy	popomoo	zguo	jperez
usha	yoonjin	horvath	ytcheng	helencxy	popomoo	zguo	jperez
usha	yoonjin	horvath	ytcheng	helencxy	popomoo	zguo	jperez
usha	yoonjin	horvath	ytcheng	haiwei	popomoo	zguo	jperez
altamash	yoonjin	horvath	ytcheng	haiwei	hongyuc	liangjl	jperez
altamash	jimkruger	faridz	ytcheng	haiwei	hongyuc	liangjl	jperez
altamash	jimkruger	faridz	ytcheng	haiwei	hongyuc	liangjl	jperez
altamash	jimkruger	faridz	khu834	jimkruger	haiwei	liangjl	jperez
altamash	jimkruger	faridz	khu834	jimkruger	haiwei	liangjl	jperez
liyuhung	jimkruger	faridz	khu834	jimkruger	yiwu	haiwei	jperez
liyuhung	jimkruger	faridz	khu834	jimkruger	yiwu	haiwei	jperez
liyuhung	jimkruger	liangjl	jimkruger	jimkruger	yiwu	haiwei	khu834
liyuhung	jimkruger	haiwei	jimkruger	jimkruger	yiwu	yiwu	khu834
tazryu78	sgchong	haiwei	jimkruger	jimkruger	fmwang	yiwu	khu834
tazryu78	sgchong	haiwei	jimkruger	jimkruger	fmwang	yiwu	khu834
tazryu78	sgchong	haiwei	jimkruger	zguo	fmwang	yiwu	hongyuc
tazryu78	sgchong		jimkruger	zguo	fmwang	popomoo	hongyuc

Previous 7 days

Tue, OCT 4	Wed, OCT 5	Thu, OCT 6	Fri, OCT 7	Sat, OCT 8	Sun, OCT 9	Mon, OCT 10	Tue, OCT 11	Wed, OCT 12
	alsune	zeyuan	jasonlin	fc3	dongrip		suyog	
	alsune	zeyuan	jasonlin	fc3	dongrip		suyog	
	alsune	suyog	jasonlin	fc3	dongrip		suyog	suyog
	spaik1	suyog		biyang	dongrip		suyog	suyog
	spaik1	suyog		biyang	dongrip		suyog	suyog
suyog	spaik1	suyog		biyang	dongrip		suyog	suyog
suyog	spaik1	suyog		biyang	dongrip		suyog	
suyog	spaik1	suyog		biyang	dongrip		suyog	
suyog				biyang	dongrip		suyog	
					dongrip		suyog	
					dongrip			
			eperalta		dongrip			
			eperalta		dongrip			joem
			eperalta					joem
			eperalta					joem
			eperalta	dongrip			jperez	joem
helencxy			jperez	dongrip		popomoo	jperez	joem
helencxy	zeyuan		jperez	dongrip		popomoo	jperez	joem
helencxy	zeyuan		jperez	dongrip		popomoo	jperez	joem
helencxy	zeyuan		jperez	dongrip		popomoo	jperez	joem
	zeyuan		jperez	haiwei		jperez	jperez	joem
	jimkruger	amet	jperez	haiwei		jperez	jperez	jimkruger
	jimkruger	amet	yiwu	haiwei		jperez	jperez	jimkruger
tkodama	jimkruger	amet	yiwu	haiwei		jperez	jimkruger	jimkruger
tkodama	jimkruger	amet	yiwu			jperez	jimkruger	jimkruger
tkodama	jimkruger	amet	yiwu			jperez	jimkruger	jimkruger
	jimkruger	ytcheng	qran			jperez	jimkruger	jimkruger
amroy	jimkruger	ytcheng	qran		khu834	jperez	jimkruger	
amroy	jimkruger	ytcheng	qran		khu834	jperez	jimkruger	
amroy	joem	ytcheng	qran		khu834	jperez	jimkruger	
khu834	joem	ytcheng	qran			jperez	jimkruger	jhaydon
khu834	joem	ytcheng		khu834	khu834		hazeghi	jhaydon
khu834	joem	ytcheng		khu834	khu834		hazeghi	jhaydon
khu834	joem	dongrip		khu834	khu834		hazeghi	jhaydon
khu834	joem	dongrip	haiwei	khu834	khu834		dongrip	jhaydon
khu834	joem	dongrip	haiwei	khu834	khu834		dongrip	jhaydon
	joem	jsnapp	haiwei	popomoo	khu834	popomoo	dongrip	jhaydon

Equipment training

Trained (Coral)



Training needed & completed

- ✓ Innotec ES26C E-Beam Evaporator (innotech) (10-11 Oct)
- ✓ STS Deep RIE Etcher (stsetch1,2)
  - Make shadow mask
  - Etch channels in Si for control
- ✓ Diffusion Wetbench (wbdiff)
  - Clean wafers prior to processing
- ✓ Wet Bench Nonmetal (wbnonmetal)
  - Clean wafers prior to processing
- ✓ Hitachi S4160 SEM (sem4160)
  - Imaging & film thickness
- ✓ Metalica

Materials needed
(Mostly standard SNF stock)

Masks & molds

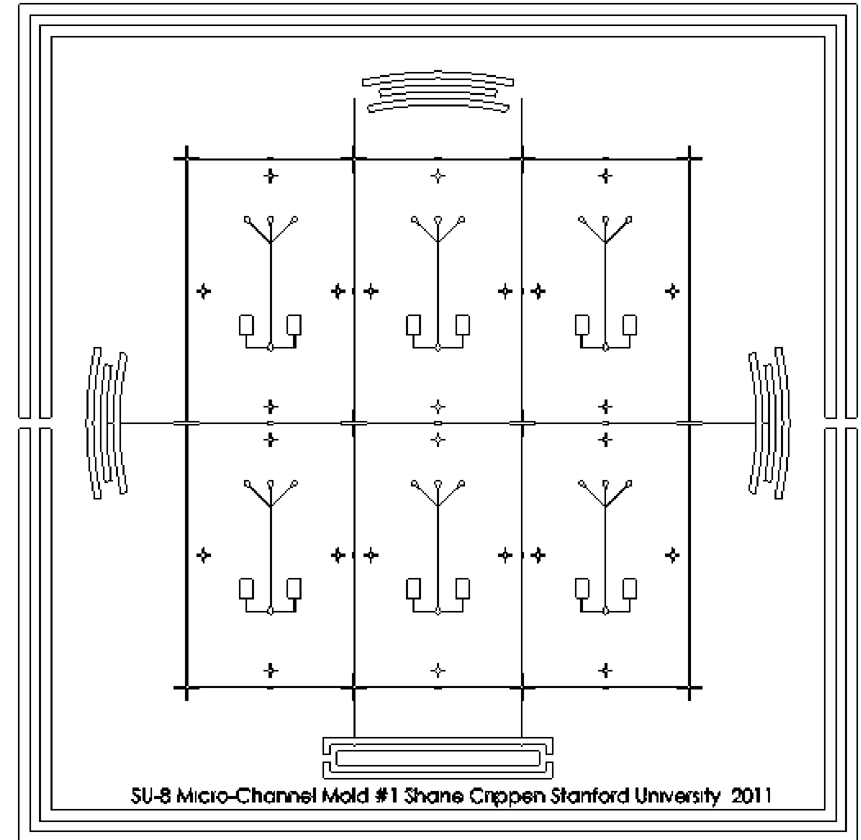
- Transparency masks
  - Transparency SU-8 channels
  - Transparency silicon channels
  - Transparency for shadow mask
  - 5” Glass/quartz to mount transparency
- Shadow mask
  - Shadow mask (silicon)
- SU-8 channel mold
  - SU-8 50 resist and developer to make molds
- PDMS channel
  - 2 part PDMS to cast against molds
  - Sylgard 184
- Silicon channels
  - Silicon wafers

Metallization

- Substrates
  - Silicon wafers
  - PDMS
- Metals
  - Au (Ti adhesion layer)

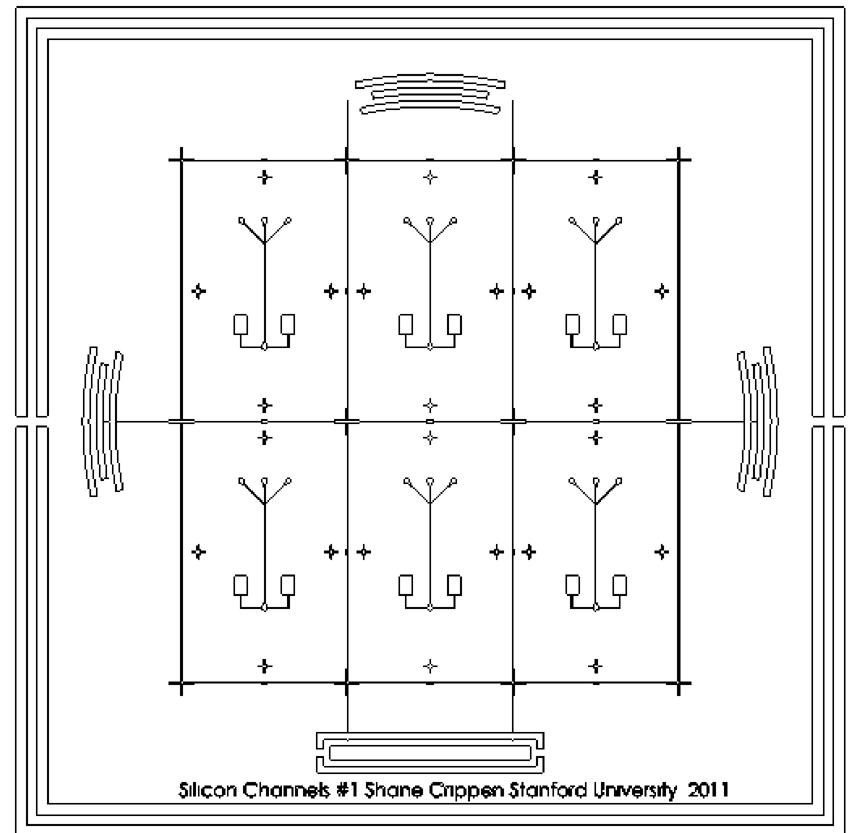
Mask development for SU-8 channels

- Standard lithography using transparency mask
- Channels all 50 µm, 1:1 aspect ratio
- Status: in hand

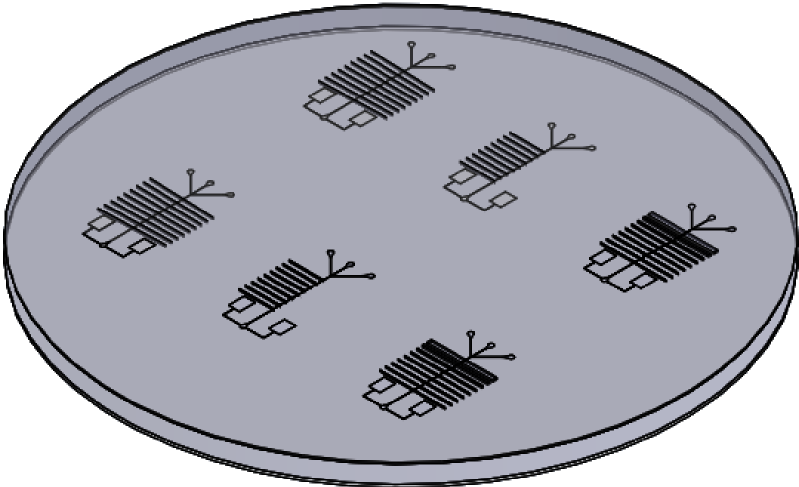


Mask development for silicon channels

- Standard lithography using transparency mask
- Same mask as the SU-8 channel mask
- Channels all 50 µm, 1:1 aspect ratio
- STS DRIE (stsetch1)
- Status: in hand



Mask development for shadow mask

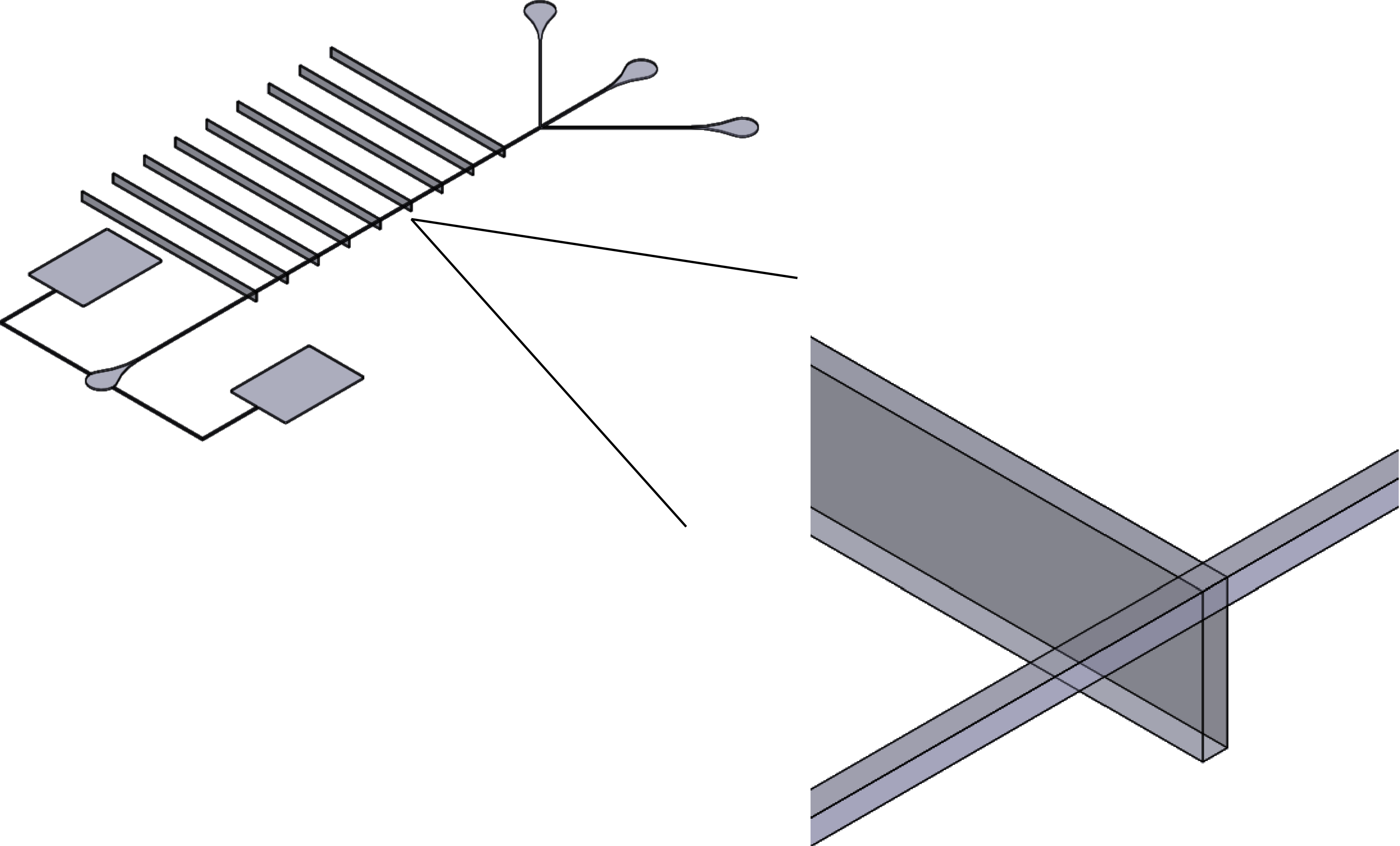


Shadow Mask
(300 µm)

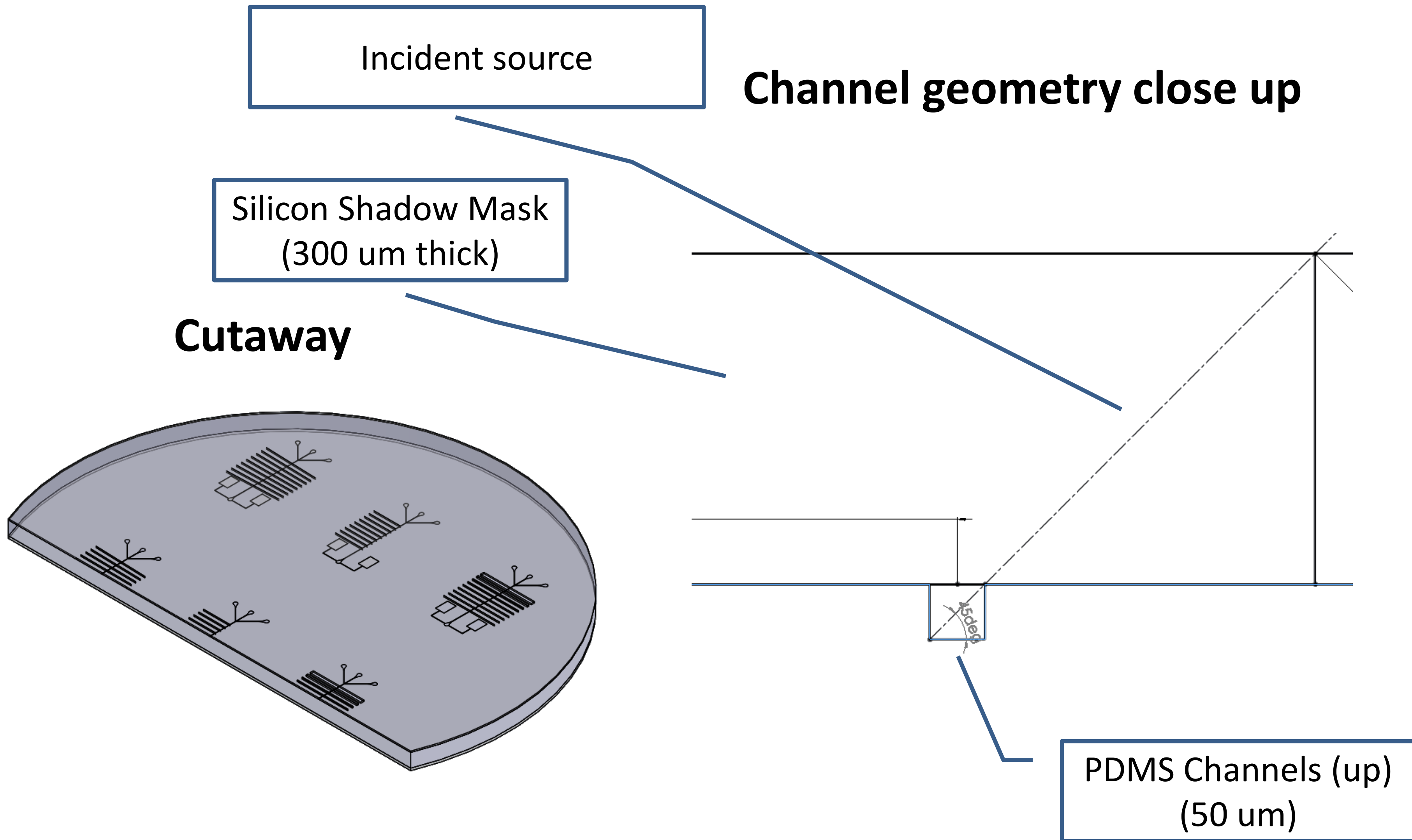
PDMS Channels (up)
(1/8”)

Backing substrate such as
silicon or quarts

Mask development for shadow mask

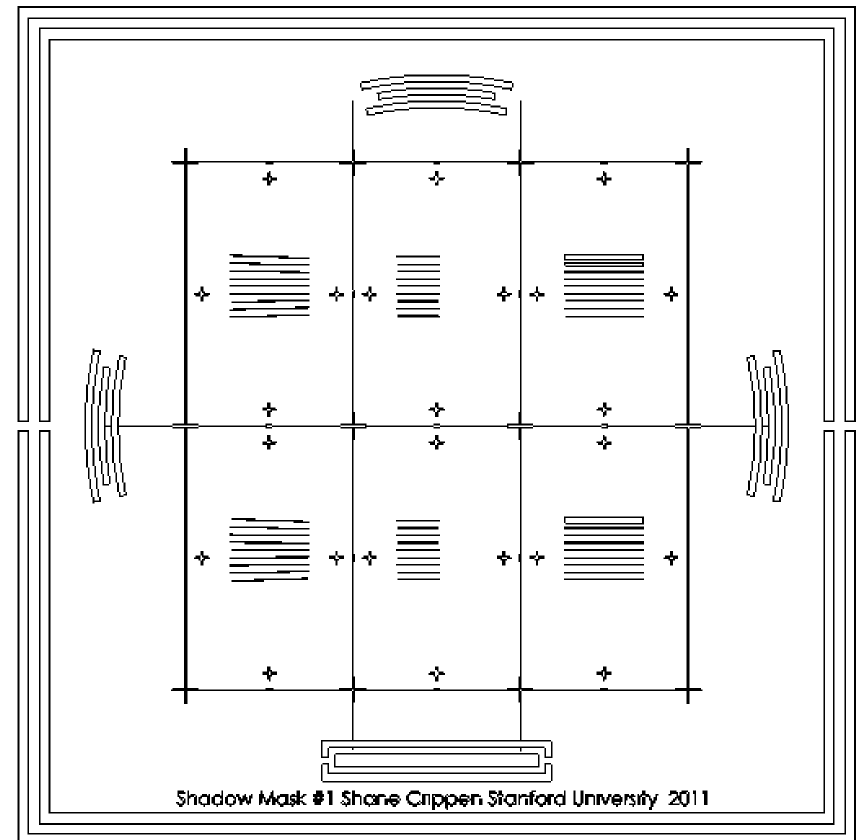


Mask development for shadow mask

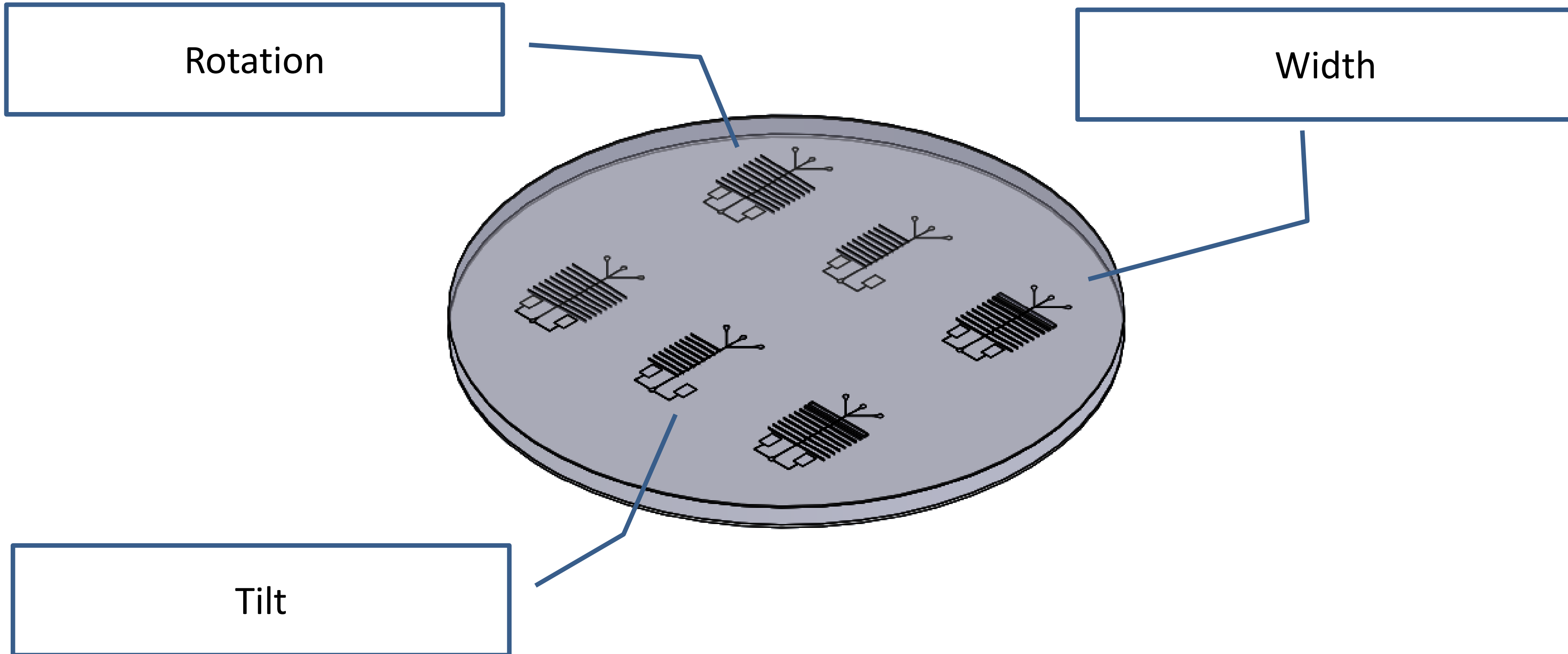


Mask development for shadow mask

- Mask regions
- Left region
  - Investigate rotation angle
- Middle region
  - Investigate tilt angle
- Right region
  - Investigate microstrip line width
- Status: in hand



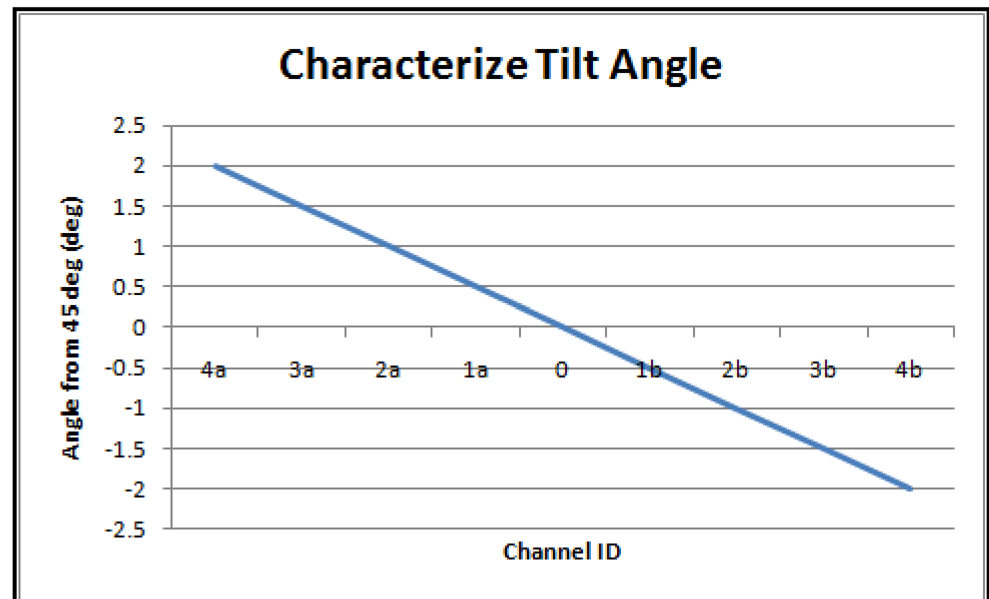
Tilt, rotation, and microstrip width



Tilt angle

Characterize Tilt Angle						
Channel ID	Width (µm)	Spacing (µm)	Delta Tilt Angle	Total Tilt Angle	Width Ratio	Delta Rotation Angle
4a	50	1125	2	47	1	0
3a	50	1125	1.5	46.5	1	0
2a	50	1125	1	46	1	0
1a	50	1125	0.5	45.5	1	0
0	50	1125	0	45	1	0
1b	50	1125	-0.5	44.5	1	0
2b	50	1125	-1	44	1	0
3b	50	1125	-1.5	43.5	1	0
4b	50	-	-2	43	1	0

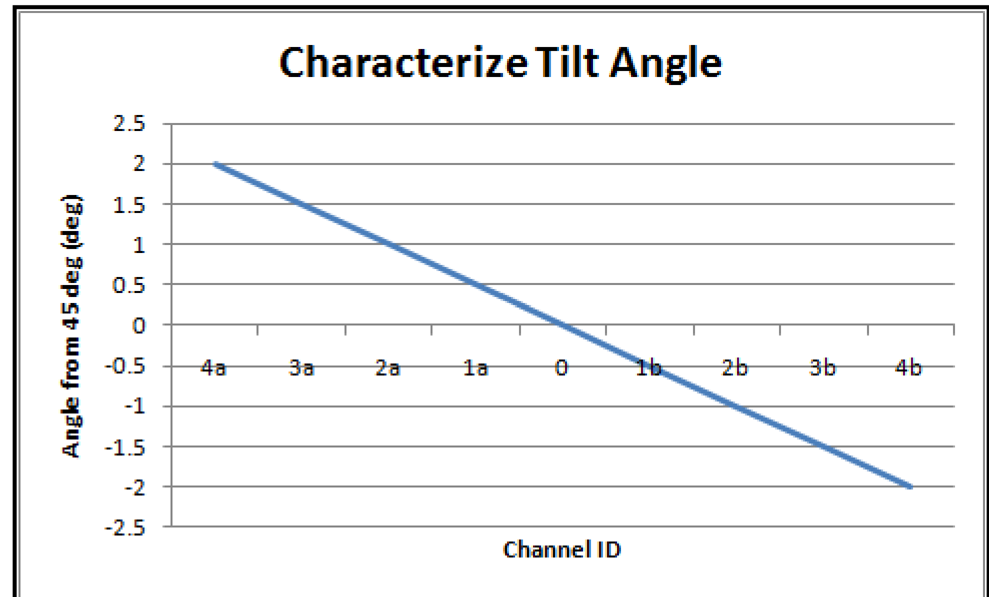
- +/- 2 deg tilt
- 9, 50 µm channels
- 0 deg rotation



Rotation angle

Characterize Rotation Angle						
Channel ID	Width (µm)	Spacing (µm)	Delta Tilt Angle	Total Tilt Angle	Width Ratio	Delta Rotation Angle
4a	50	1125	0	45	0.2	2
3a	50	1125	0	45	0.2	1.5
2a	50	1125	0	45	0.2	1
1a	50	1125	0	45	0.2	0.5
0	50	1125	0	45	0.2	0
1b	50	1125	0	45	0.2	-0.5
2b	50	1125	0	45	0.2	-1
3b	50	1125	0	45	0.2	-1.5
4b	50	-	0	45	0.2	-2

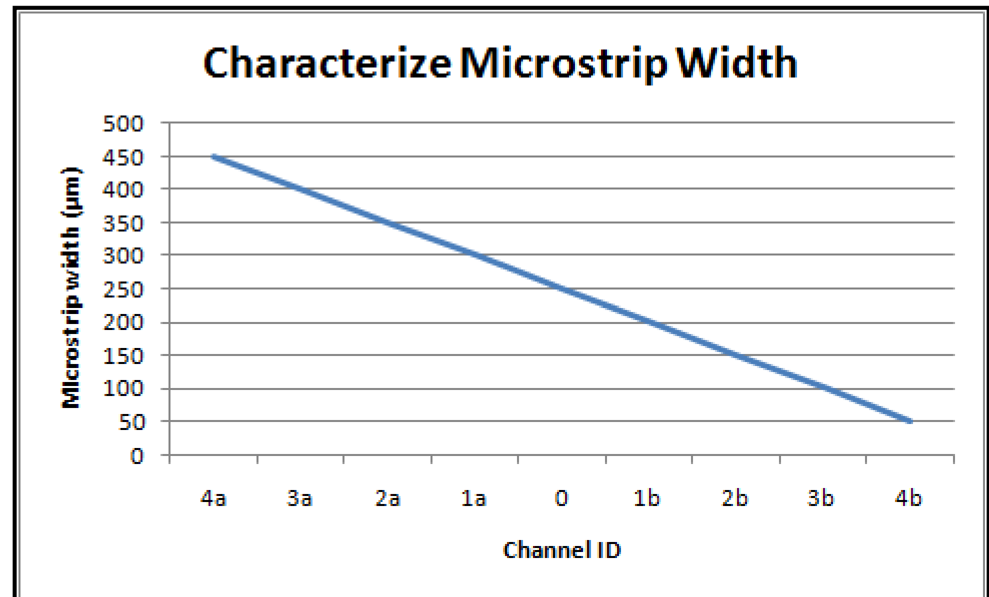
- +/- 2 deg rotation
- 0 deg tilt
- 9, 50 µm channels



Microstrip width

Characterize Microstrip Width						
Channel ID	Width (μm)	Spacing (μm)	Delta Tilt Angle	Total Tilt Angle	Width Ratio	Delta Rotation Angle
4a	450	1125	0	45	9	0
3a	400	1125	0	45	8	0
2a	350	1125	0	45	7	0
1a	300	1125	0	45	6	0
0	250	1125	0	45	5	0
1b	200	1125	0	45	4	0
2b	150	1125	0	45	3	0
3b	100	1125	0	45	2	0
4b	50	-	0	45	1	0

- 50-450 μm
  - – Aspects 1:1-9:1
- 0 deg tilt
- 0 deg rotation



SU-8 channel mold

- Standard lithography

Task	Resources
Substrate Pretreatment	Wet Bench Diffusion
Dehydrate (optional if YES)	Hot Plate
Coat	Headway,SU-8-50 Resist[1]
Soft Bake 6/20	Hot Plate
Expose	Karl Suss,Transparency Mask SU-8
Post Exposure Bake 1/5	Hot Plate
Develop	Wet Bench General
Rinse and Dry	Wet Bench General
Hard Bake (optional)	Hot Plate
Coat with Protective Resist for Dicing	SVG Coater Track 1,Shipley 3612 Resist
Dice (or scribe)	Wafer Saw
Remove Protective Resist	Wet Bench General

PDMS casting process

- Standard replica molding

Task	Resources
Mix	Scale
Pour	
Degas	Degasser
Cure/bake	Oven
Cut	

Silicon channel process

- STS DRIE (stsetch1)
- Etch 50 μm to create similar channels as PDMS
- Substrate comparison

Task	Resources
Substrate Pretreatment	Wet Bench Diffusion
Coat	SVG Coater Track 2,SPR 220-3 Resist[1]
Soft Bake (optional if bake program 3)	Hot Plate
Expose	Karl Suss,Transparency Mask Silicon Channels
Post Exposure Bake (not required for SPR 220-3)	Oven
Develop	SVG Developer[1]
Etch (Deep)	STS Deep RIE Etcher

Shadow mask process

- Etching through wafer (300 µm)

Task	Resources
Substrate Pretreatment	Wet Bench Diffusion
Mount wafer	SVG Coater Track 1,Shipley 3612 Resist
Coat	SVG Coater Track 1,SPR 220-7 Resist[1]
Soft Bake (optional if bake program 3)	Hot Plate
Expose	Karl Suss,Transparency Mask Shadow Mask
Post Exposure Bake	Oven
Develop	SVG Developer[1]
Mount Wafer to Support Wafer	Polyimide Tape
Etch	STS Deep RIE Etcher

Suggestions?

Extra Slides