RIE2 of Silicon

(etching of small structures ~1.5µm)

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Introduction

- The aim is to get an overview of the how responses: *etch rate*, *selectivity* and *sidewall angle,* varies as a function of O2 flow and CHF3 flow for a silicon etch designed for etching nanostructures. This is tested on 1.5 µm lines.

- In the chosen parameter regime O2 is the sidewall passivating gas and SF6 and CHF3 are the isotropic etching gases. By keeping SF6 flow constant you can obtain both positive and negative tapered sidewalls by changing the ratio between O2 flow and CHF3 flow.

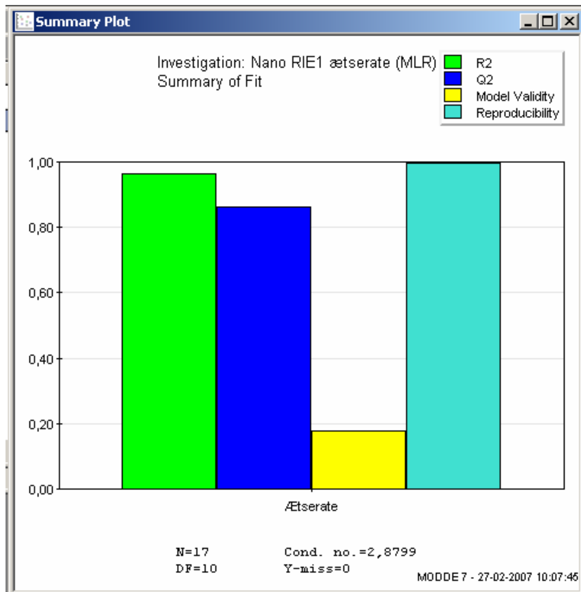
- Etch rate, selectivity and sidewall angles depends a lot on the mask load. Here is chosen a mask load close to 75% to simulate a 2” wafer with small holes in the resist defined by e-beam on a 4” Si-carrier wafer. When this work needs to be used for work with mask loads fare from 75% then only the qualitative trends on how the responses varies with chance in the parameters can be used.

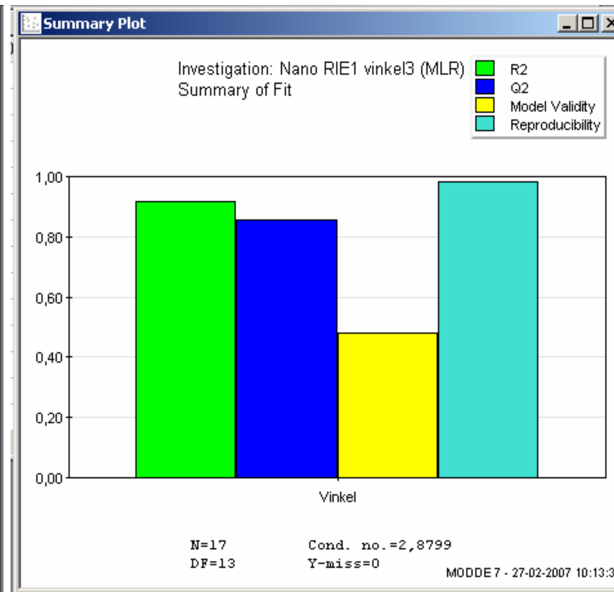
Experimental design and results

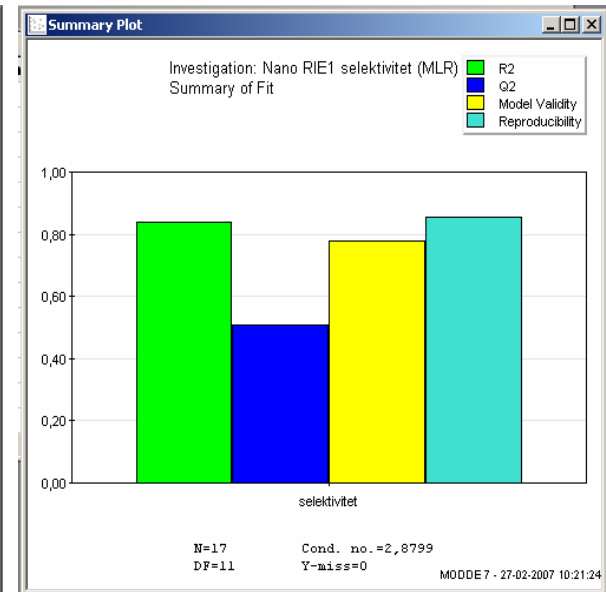
SF6 flow: 30sccm – pressure: 36mTorr – Power: 20W – Temperature: 300℃ – Etch time: 10 min – Mask load: ~75-80% - Mask: 1.5 µm AZ resist

	1	2	3	4	5	6	7	8	9	10
1	Exp No	Exp Name	Run Order	Incl/Excl	O2	CHF3	tryk	Ætserate	Selektivitet	Angle
2	1	N1	7	Incl	20	5	31	147	2,19	91
3	2	N2	1	Incl	29	5	31	119	1,63	81
4	3	N3	16	Incl	20	15	31	77	1,45	87
5	4	N4	12	Incl	29	15	31	82	1,49	79
6	5	N5	2	Incl	20	5	41	140	3,11	93,1
7	6	N6	11	Incl	29	5	41	105	1,75	81,3
8	7	N7	14	Incl	20	15	41	89	2,12	90,5
9	8	N8	17	Incl	29	15	41	105	2,39	77
10	9	N9	13	Incl	20	10	36	121	2,47	91,2
11	10	N10	15	Incl	29	10	36	94	1,65	80,7
12	11	N11	10	Incl	24,5	5	36	118	1,87	87,5
13	12	N12	8	Incl	24,5	15	36	82	1,58	89,2
14	13	N13	6	Incl	24,5	10	31	105	1,64	87,8
15	14	N14	4	Incl	24,5	10	41	101	1,81	87
16	15	N15	3	Incl	24,5	10	36	105	2,06	90,8
17	16	N16	9	Incl	24,5	10	36	104	1,86	89,9
18	17	N17	5	Incl	24,5	10	36	106	1,74	89,6

Model fit







Etch rate

The model fits very well. The model validity is a little low. This is due to the very high reproducibility

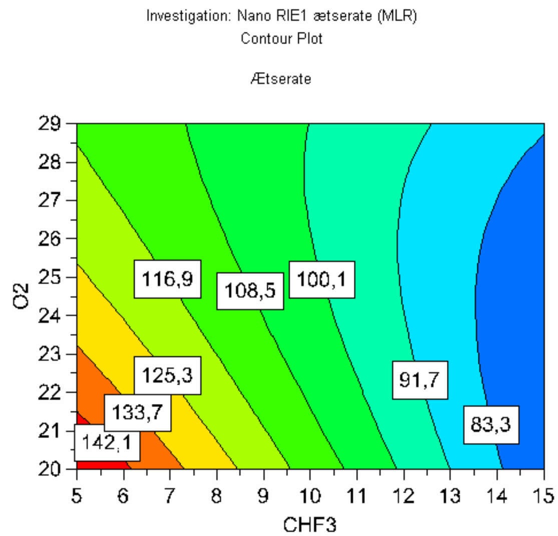
Angle

The model fits very well.

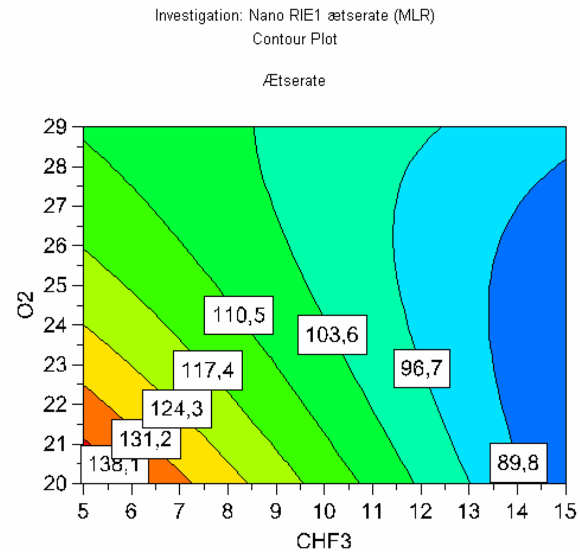
selectivity

The model does not fit very well. May due to an outlier.

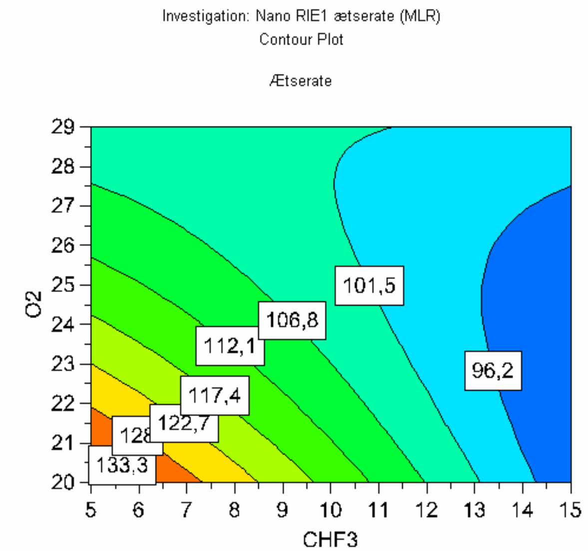
Contour plots for the etch rate



Pressure = 31 mTorr

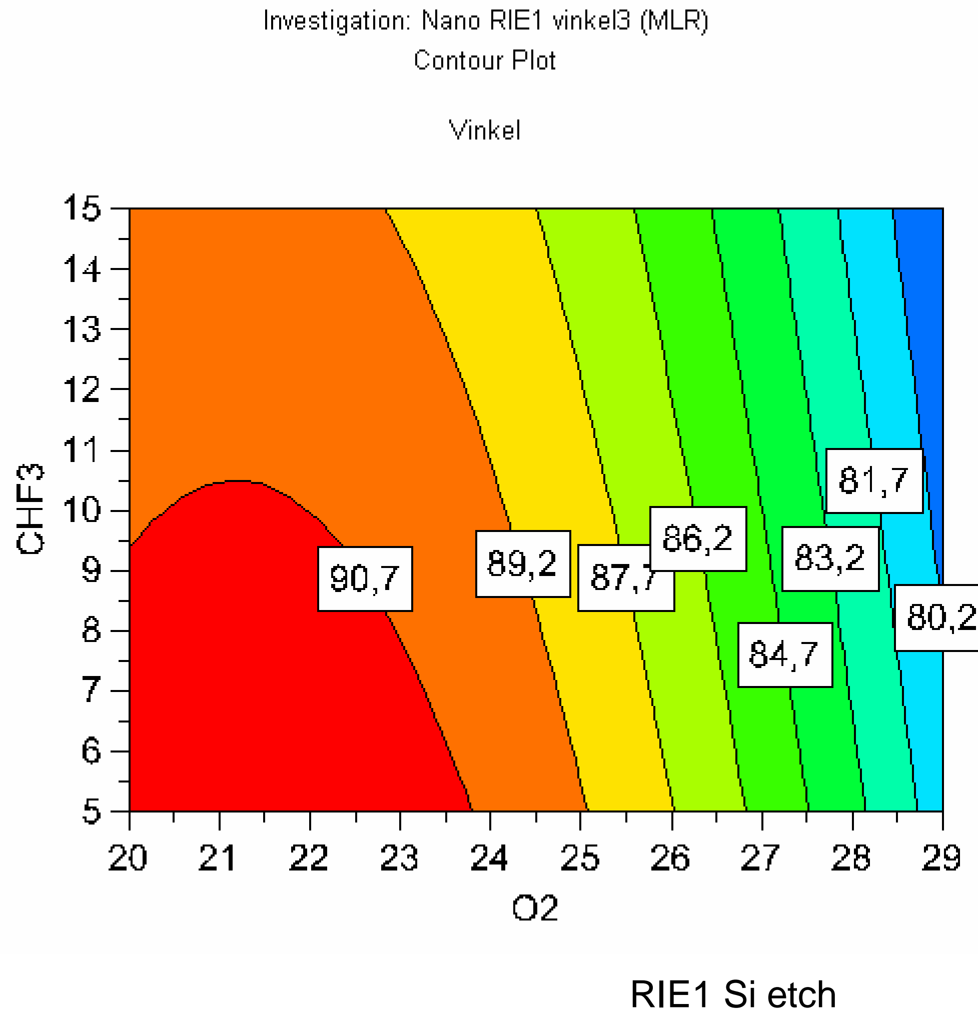


Pressure = 36mTorr



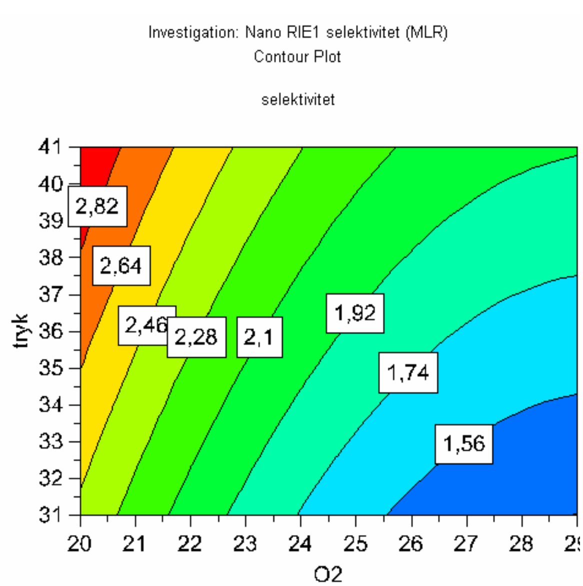
Pressure = 41 mTorr

Contour plot for the sidewall angle

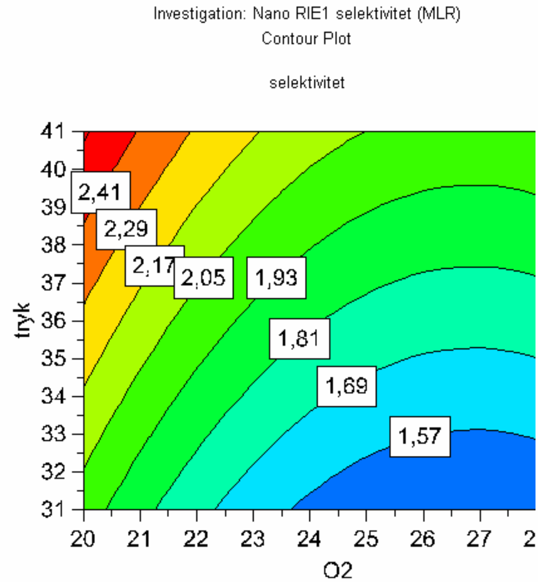


Notice that the value of the pressure do not affect the sidewall angle significantly in the chosen pressure range

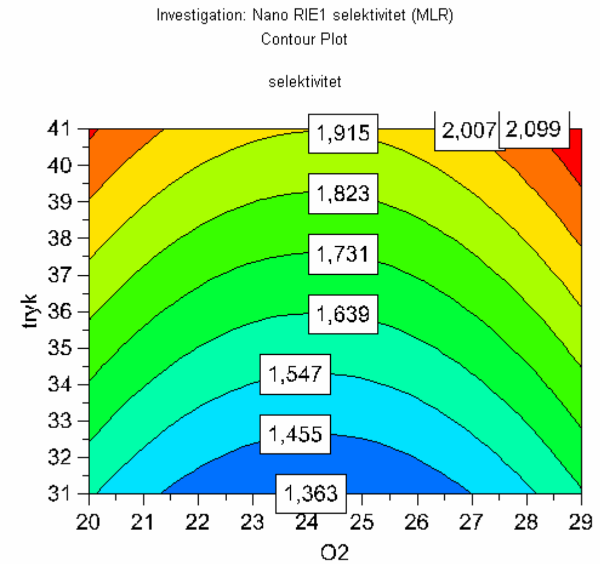
Contour plot for the selectivity



CHF3 flow =5 sccm

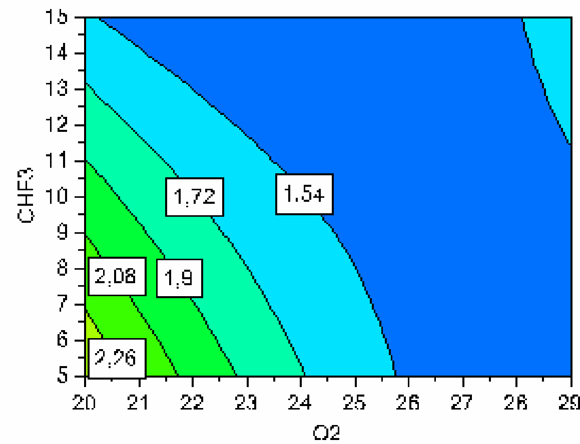


CHF3 flow = 10 scccm

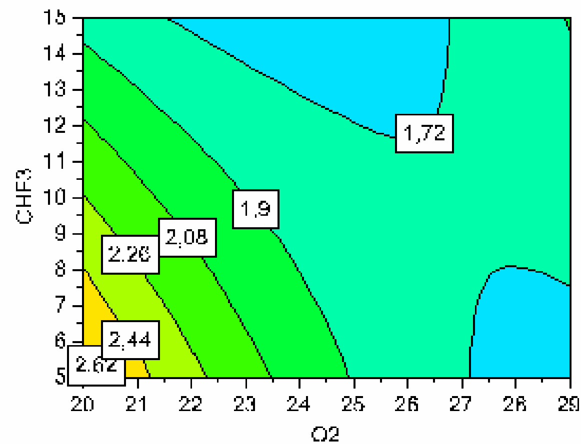


CHF3 flow = 15 sccm

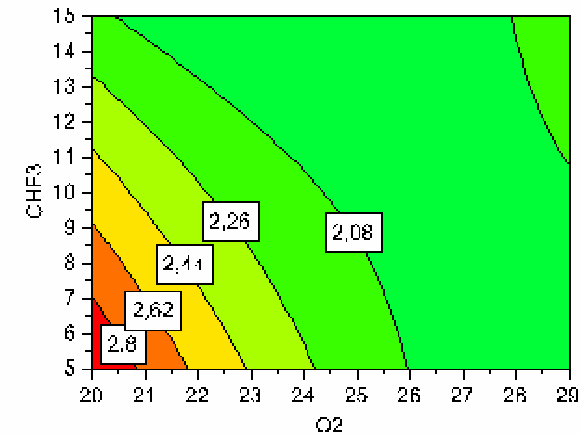
Contour plots of the selectivity



Pressure: 31 mTorr

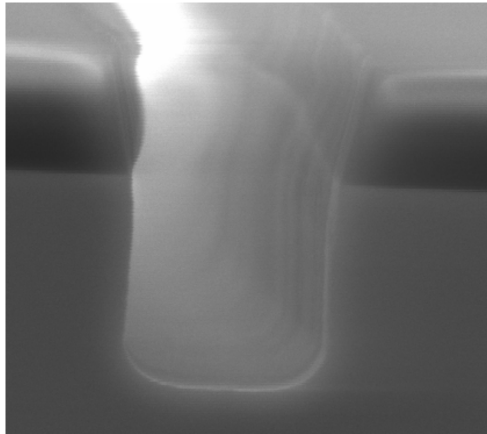


Pressure: 36 mTorr

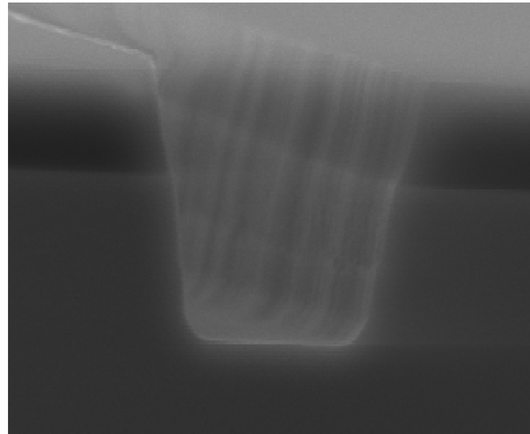


Pressure: 41 mTorr

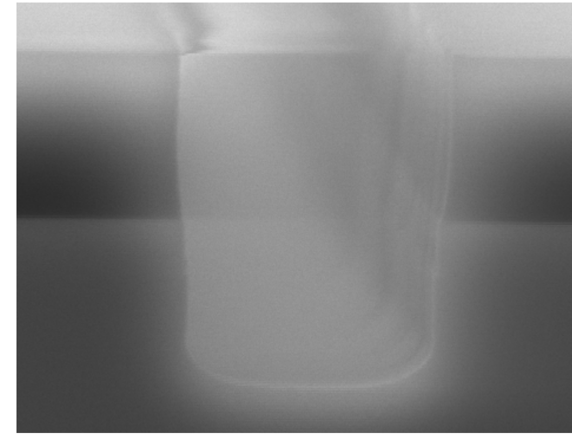
Experiments 1-6



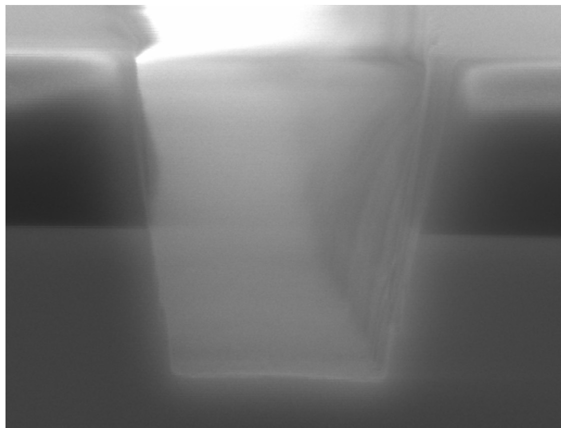
O2:20sccm CHF3: 5sccm P=31mTorr



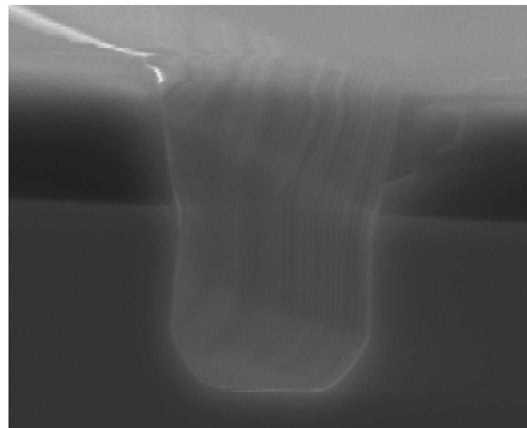
O2:29sccm CHF3: 5sccm P=31mTorr



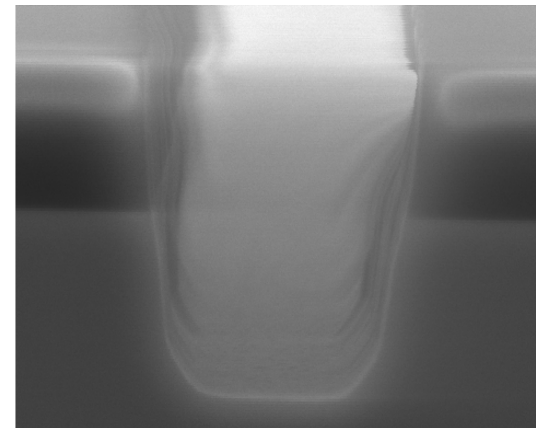
O2:20sccm CHF3: 15sccm P=31mTorr



O2:29sccm CHF3:15sccm P=31mTorr

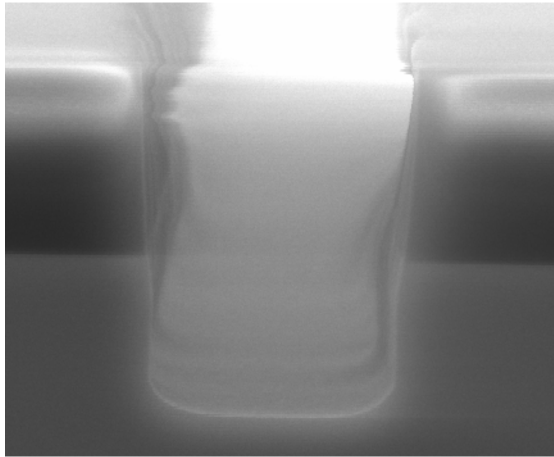


O2:20sccm CHF3: 5sccm P=41mTorr

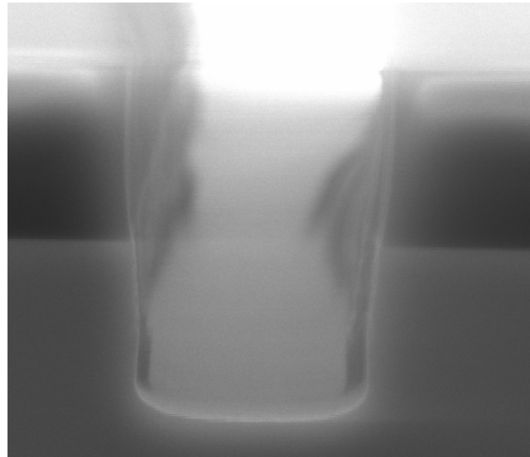


O2:29sccm CHF3: 5sccm P=41mTorr

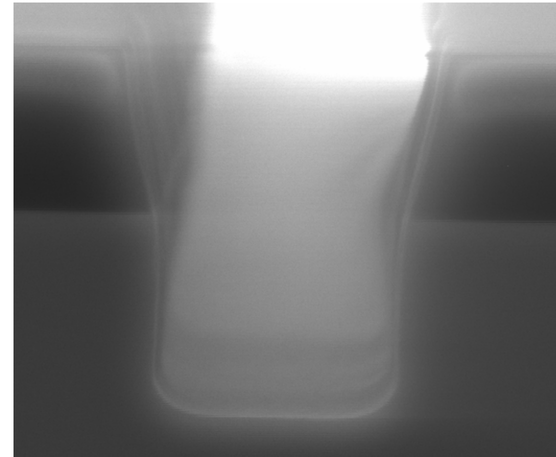
Experiments 7-12



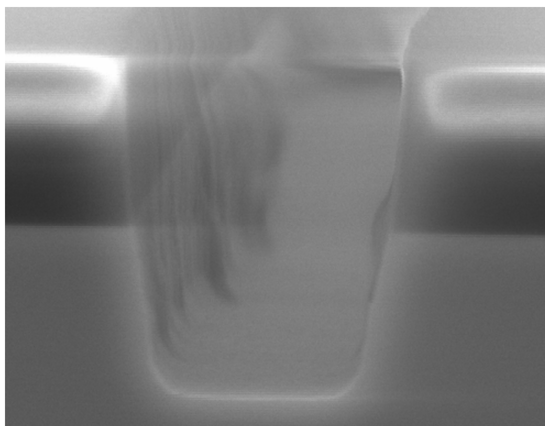
O2:20sccm CHF3:15sccm P=41mTorr



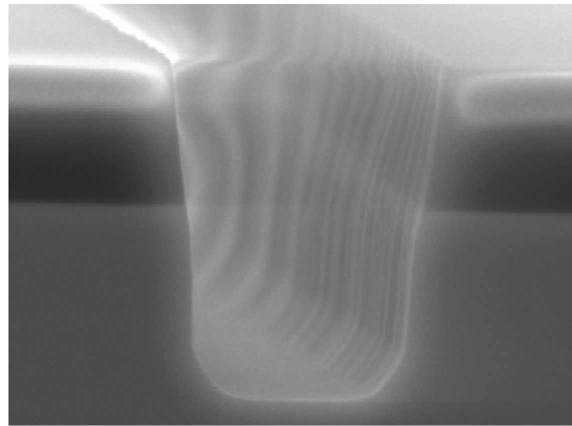
O2:29sccm CHF3: 15sccm P=41mTorr



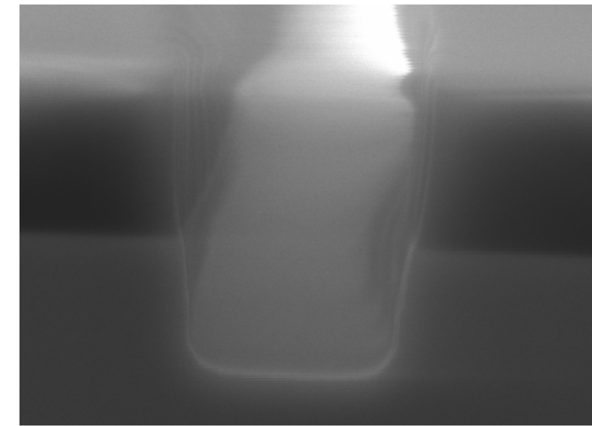
O2:20sccm CHF3: 10sccm P=36mTorr



O2:29sccm CHF3:10sccm P=36mTorr

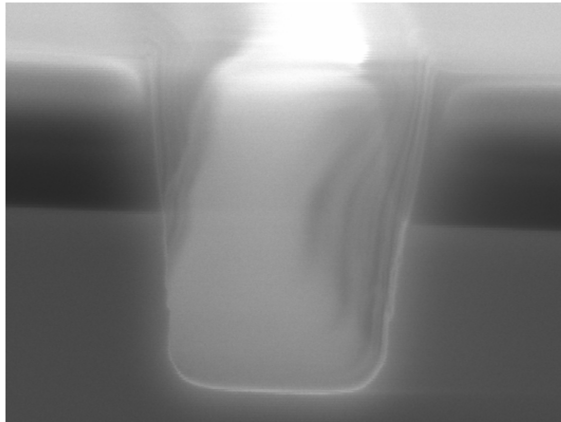


O2: 24.5sccm CHF3: 5sccm P=36mTorr

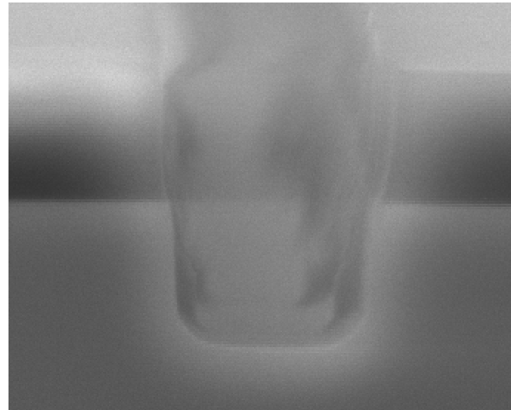


O2:24.5sccm CHF3: 15sccm P=36mTorr

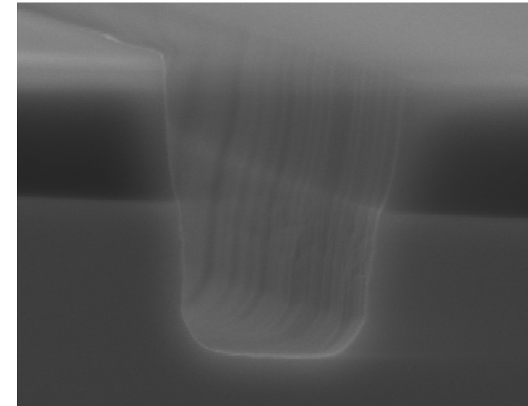
Experiments 13-17



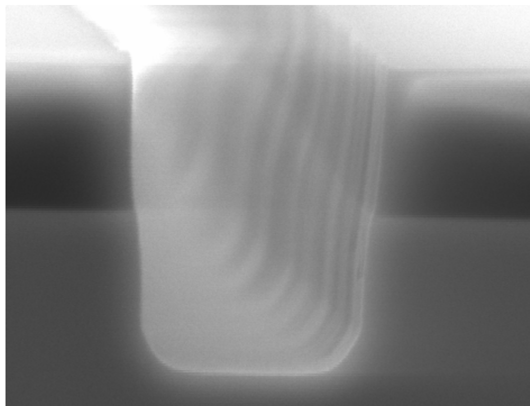
O2:24.5sccm CHF3: 10sccm P=36mTorr



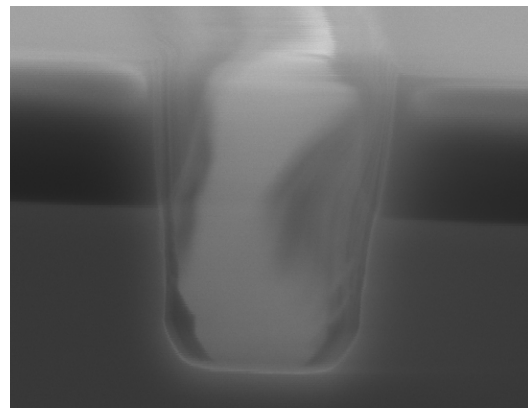
O2:24.5sccm CHF3:10sccm P=41mTorr



O2:24.5sccm CHF3: 10sccm P=36mTorr



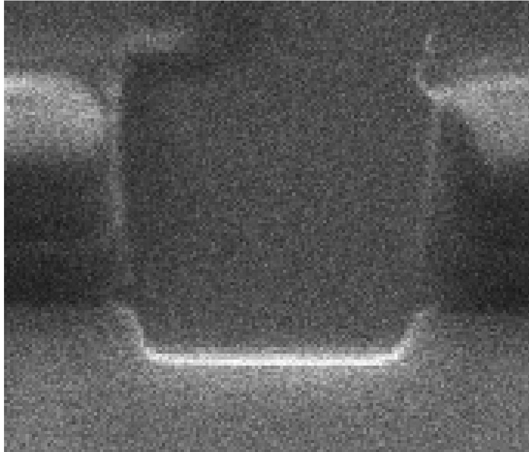
O2:24.5sccm CHF3:10sccm P=36mTorr



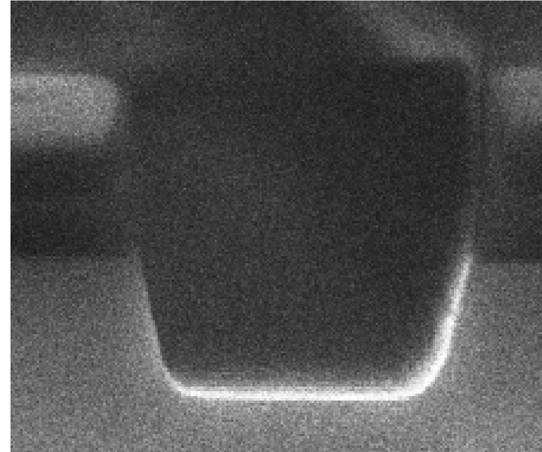
O2:24.5sccm CHF3: 10sccm P=36mTorr

Same recipe – different etch depth

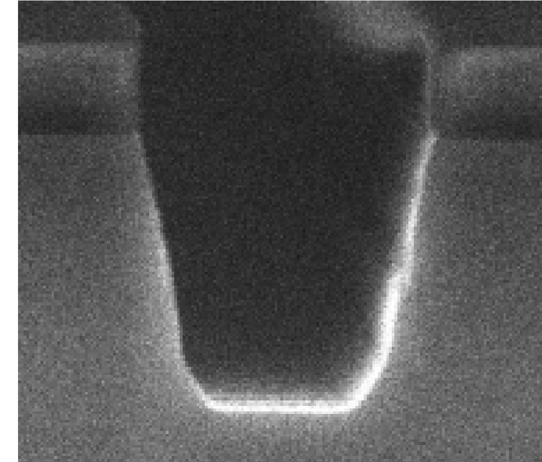
4 min.



10 min.



20 min.



Recipe no. 8: O_2: 29sccm CHF_3: 15sccm Pressure: 41mTorr

	4 min.	10 min.	20 min.
Etch rate [nm/min]	70	71	78
Selectivity	1.47	1.48	1.77
Sidewall angle	65.1	76.9	78.5

Test of model within model limits