Sn komponensek Si mátrixban

PETŐ Gábor[1], DARÓCZI Csaba Sándor[1] és Janusz KANSKI[2].

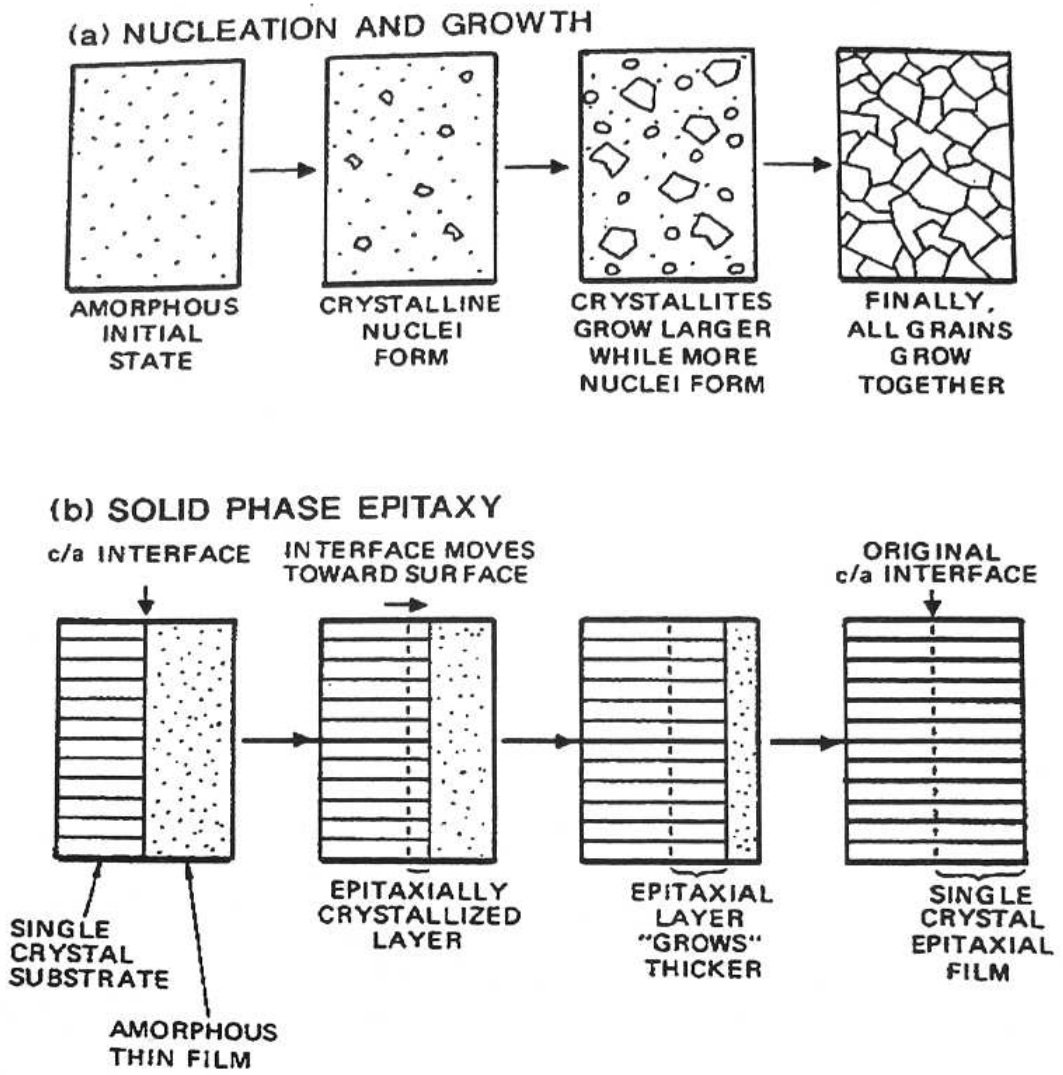
[1]MTA TTK MFA, H-1121 Budapest, Konkoly-Thege M. út 29-33.

[2]Chalmers Univ. Techn. Appl. Phys. Dept., 41296 Göteborg, Sweden.

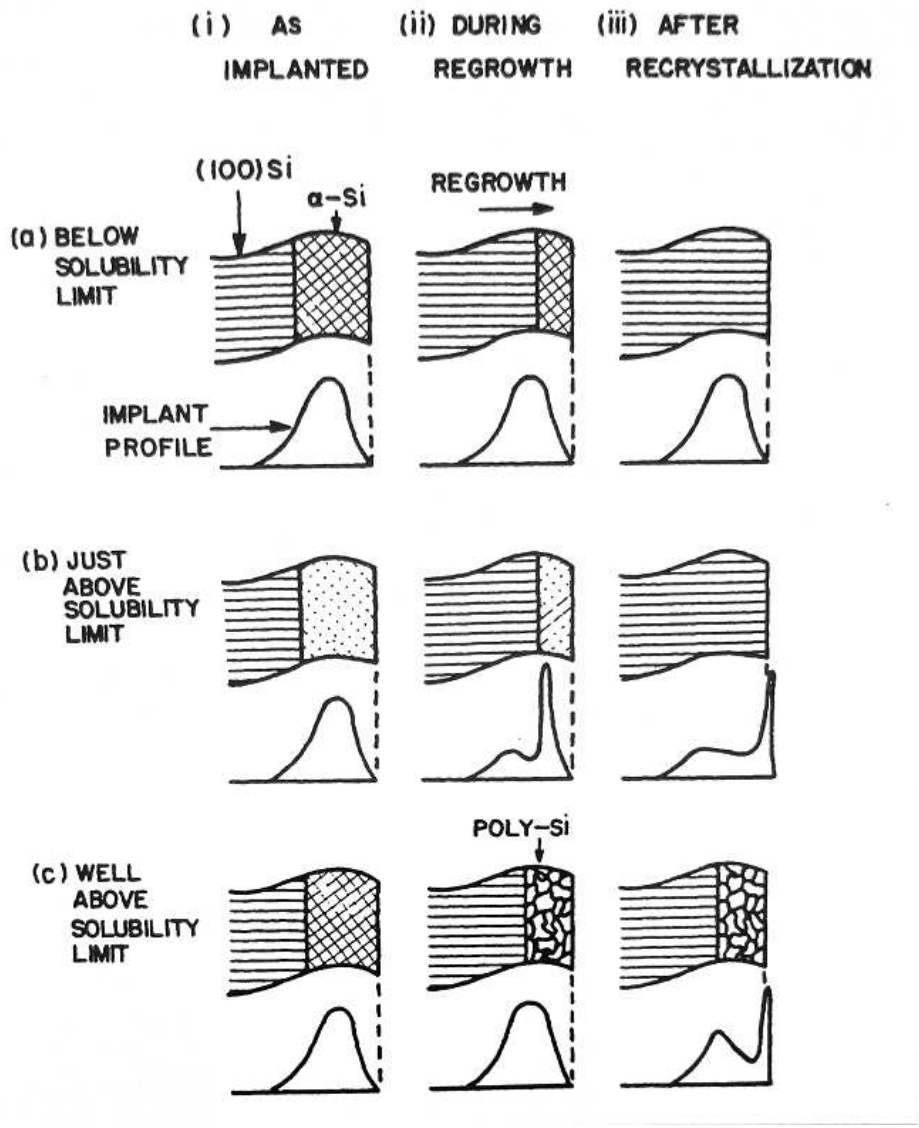
- IV és IV-IV oszlop elemei a mikro- és nanoelektronika tartó oszlopai
- C, Si, Ge, Sn, Si-Ge a legnagyobb siker a XX. század végén (grafén?)
- Sn - az ismeretlen „kistestvér”

• A rendszer jellemzésére az atomi nívókat alkalmazzuk a felületen

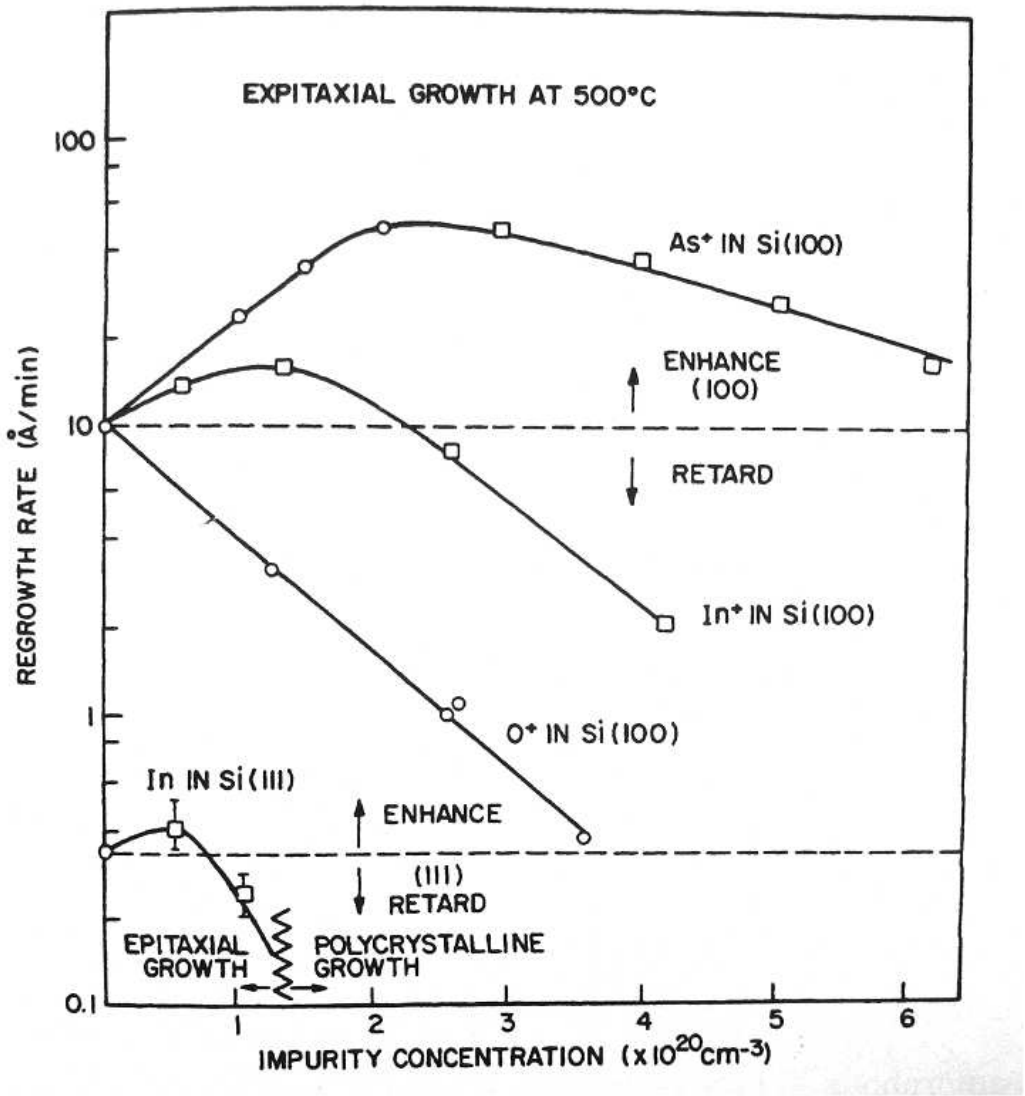
• Kísérleti módszer: fotoelektron-spektroszkópia, szinkrotron sugárzásos fotoelektronok energia-eloszlása



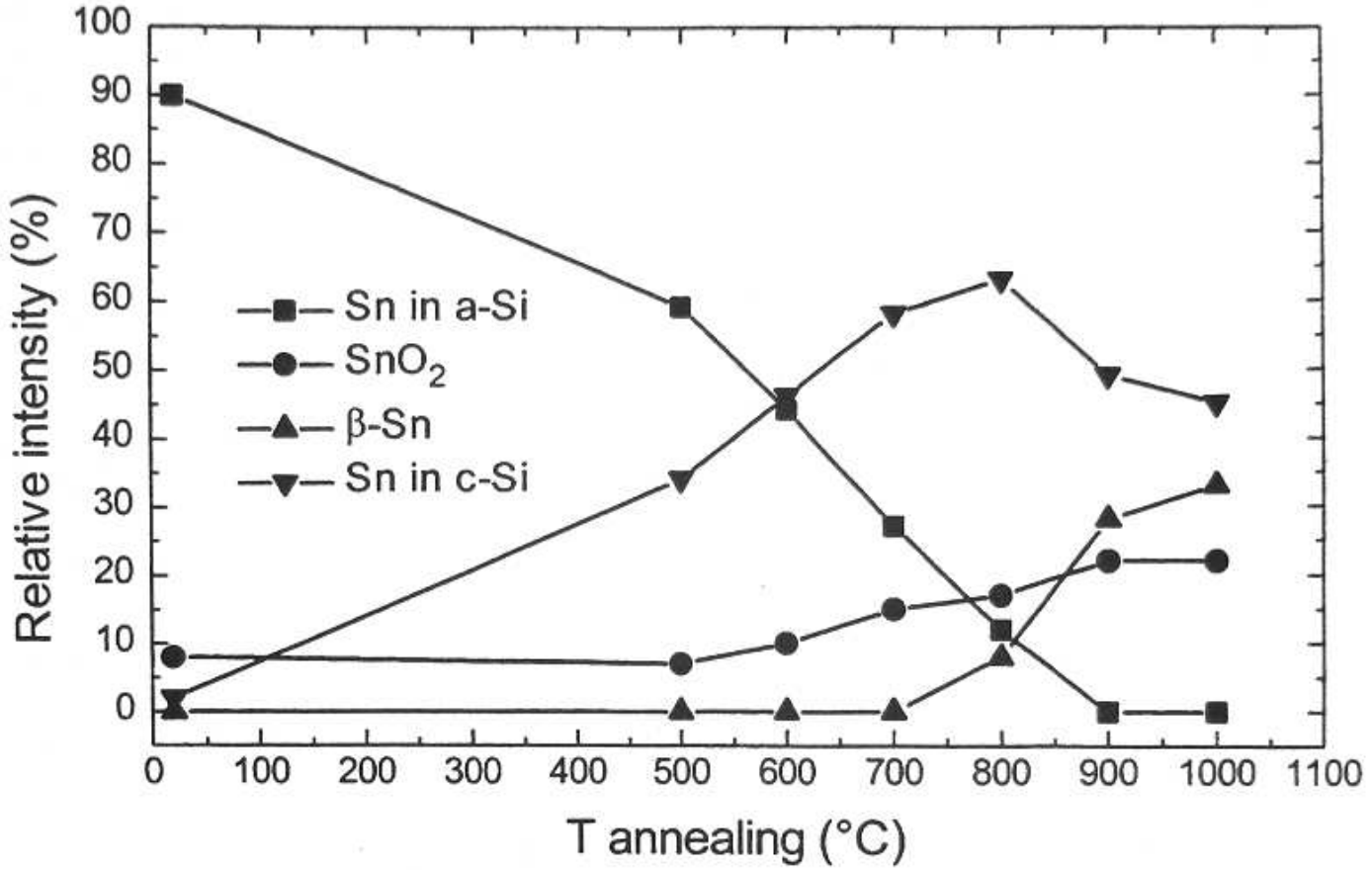
Schematic illustration of solid phase crystallisation process in a-Si. (a) Random nucleation, (b) solid phase epitaxy.



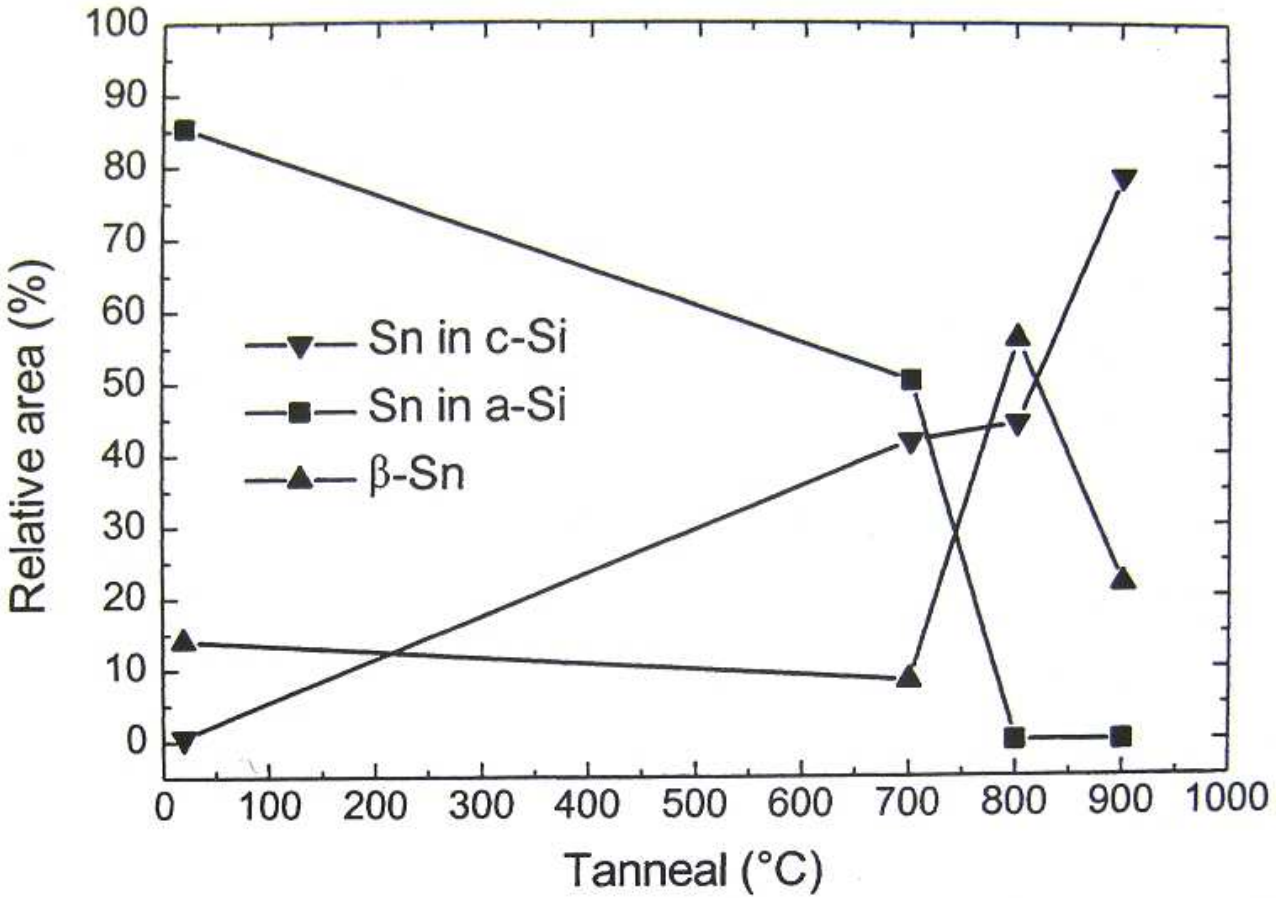
Schematic illustrating the typical regrowth details and dose dependance for <600 °C annealing of ion implanted (100) Si.



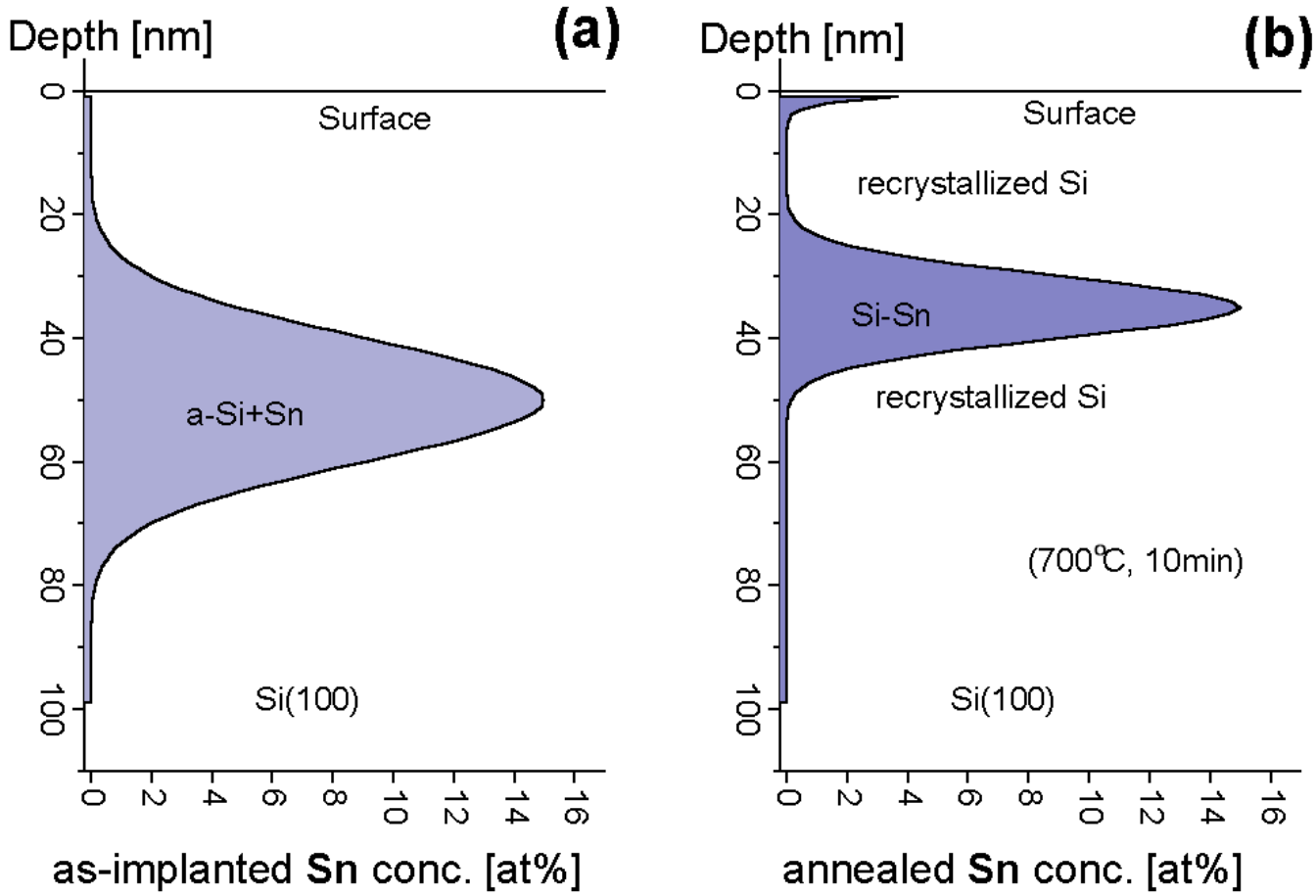
Epitaxial regrowth rates of amorphous Si on (100) and (111) Si at, and extrapolated to, 500 °C as a function of impurity concentration.

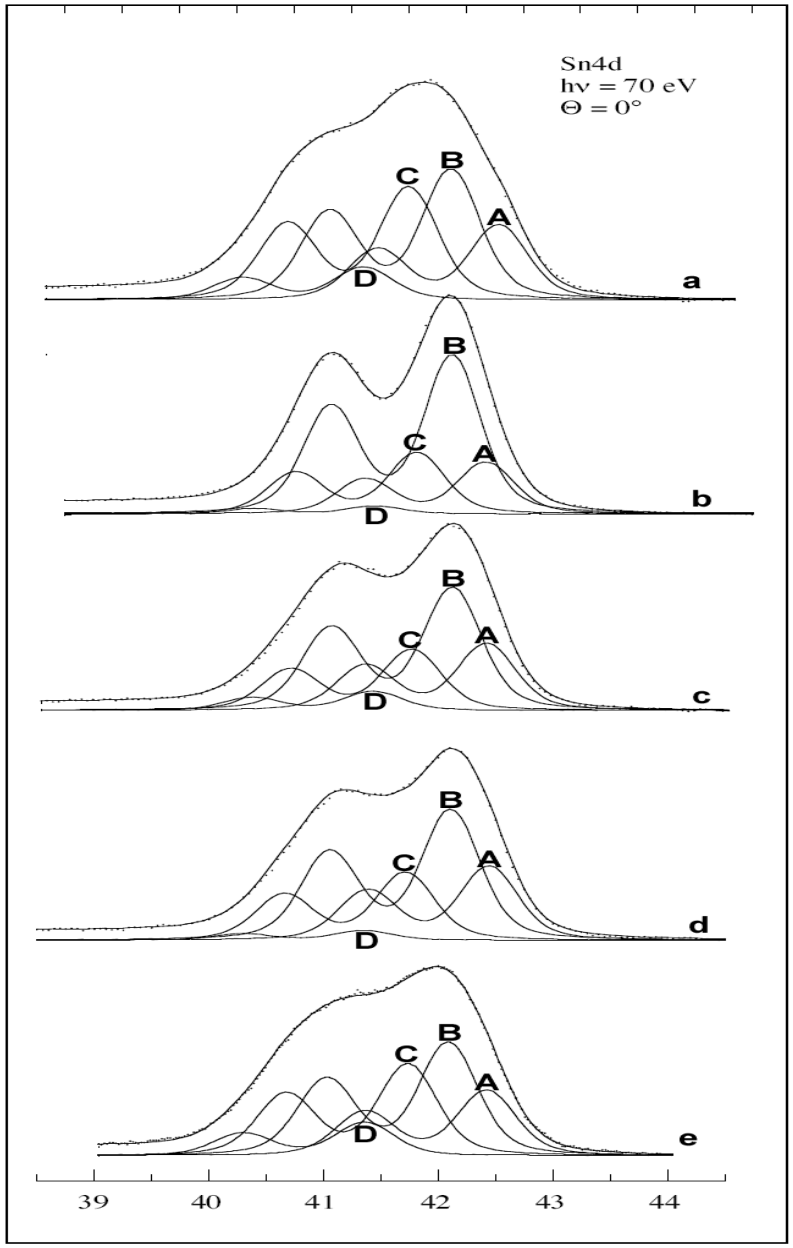


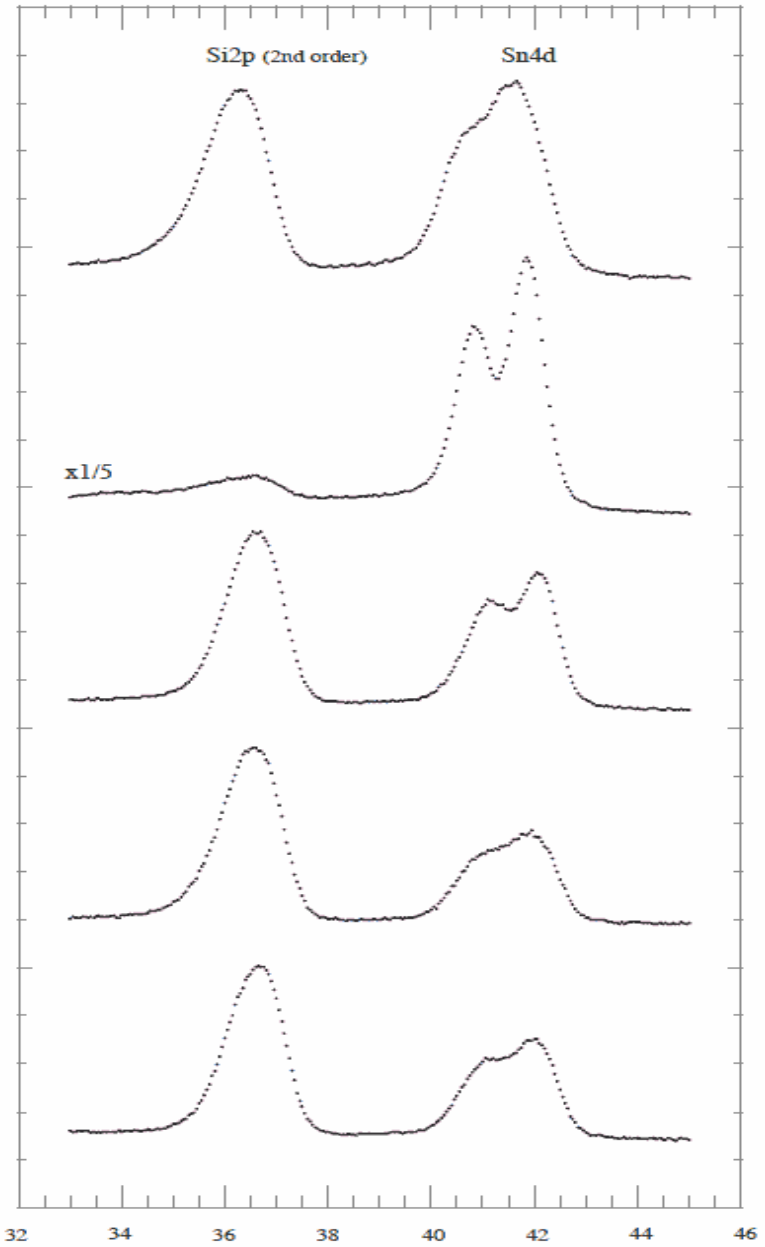
Dependence on the annealing temperature of the relative intensity of the components for sample 6 (5 at% implanted at RT)



Relative spectral intensity of the different components from sample 2C (10 at%) as a function of the annealing temperature.


Depth [nm]
(a)
Surface
a-Si+Sn
Si(100)
0
20
40
60
80
100
0
2
4
6
8
10
12
14
16
as-implanted Sn conc. [at%]
Depth [nm]
(b)
Surface
recrystallized Si
Si-Sn
recrystallized Si
(700℃, 10min)
Si(100)
annealed Sn conc. [at%]


Sn4d
hν = 70 eV
Θ = 0°
A
B
C
D
a
b
c
d
e
39
40
41
42
43
44


Si2p (2nd order)
Sn4d
x1/5
32
34
36
38
40
42
44
46

Survey of fitting parameters for Sn spectrum after final annealing, before last sputtering:

peak#/symbol	energy (eV)	Γ_{Lor}(eV)	Γ_{Gauss}(eV)	ΔE_{S-O}(eV)	Br.ratio
1/□	29.83	0.22	0.500	1.047	1.46
2/Δ	30.59	"	"	"	"
3/●	30.91	"	"	"	"
4/x	31.22	"	"	"	"

The best fits were obtained with integrated background (Shirley).

Sputtered 30min

Centroid	Lor_FWidthHM	Area	Log10(Area)
30.951,	.220,	5.537325E+00,	.74
30.562,	.220,	5.800495E+00,	.76
31.318,	.220,	3.119014E+00,	.49
30.147,	.220,	1.766602E+00,	.25

S-O shift	Branch Ratio	Gaus FWidthHM	Sing
1.047,	1.460,	.500,	.000,

The sum of the squares of the residual divided by the number of points is 0.825E-02

heated 4.5A 10min

Centroid	Lor_FWidthHM	Area	Log10(Area)
30.948,	.220,	1.022266E+01,	1.01
30.564,	.220,	7.816061E+00,	.89
31.321,	.220,	5.753954E+00,	.76
30.162,	.220,	1.490241E+00,	.17

S-O shift	Branch Ratio	Gaus FWidthHM	Sing
1.047,	1.460,	.500,	.000,

The sum of the squares of the residual divided by the number of points is 0.118E-01

5.5A 10min

Centroid	Lor_FWidthHM	Area	Log10(Area)
30.945,	.220,	1.698713E+01,	1.23
30.569,	.220,	1.181385E+01,	1.07
31.313,	.220,	8.874202E+00,	.95
30.122,	.220,	1.951743E+00,	.29

S-O shift	Branch Ratio	Gaus FWidthHM	Sing
1.047,	1.460,	.500,	.000,

The sum of the squares of the residual divided by the number of points is 0.164E-01

6.0A 1min + 6.5A 3min

Centroid	Lor_FWidthHM	Area	Log10(Area)
30.908,	.220,	1.091708E+02,	2.04
30.594,	.220,	3.170195E+01,	1.50
31.217,	.220,	1.429937E+01,	1.16
29.834,	.220,	5.263073E+00,	.72

S-O shift	Branch Ratio	Gaus FWidthHM	Sing
1.047,	1.460,	.500,	.000,

The sum of the squares of the residual divided by the number of points is .140

sputtered 15min

Centroid	Lor_FWidthHM	Area	Log10(Area)
30.895,	.220,	3.107914E+01,	1.49
30.514,	.220,	1.625401E+01,	1.21
31.263,	.220,	1.078194E+01,	1.03
30.036,	.220,	2.948151E+00,	.47

S-O shift	Branch Ratio	Gaus FWidthHM	Sing
1.047,	1.460,	.500,	.000,

The sum of the squares of the residual divided by the number of points is .169

A(024,1999)

Peak	Position (eV)	Area	FWHM (eV)
0	23.334	26.481	0.500
1	23.756	52.500	0.500
2	24.142	53.150	0.500
3	24.570	21.119	0.500

B(033,1999)

Peak	Position (eV)	Area	FWHM (eV)
0	23.440	10.605	0.500
1	23.836	65.068	0.500
2	24.157	60.213	0.500
3	24.572	13.142	0.500

C(037,1999)

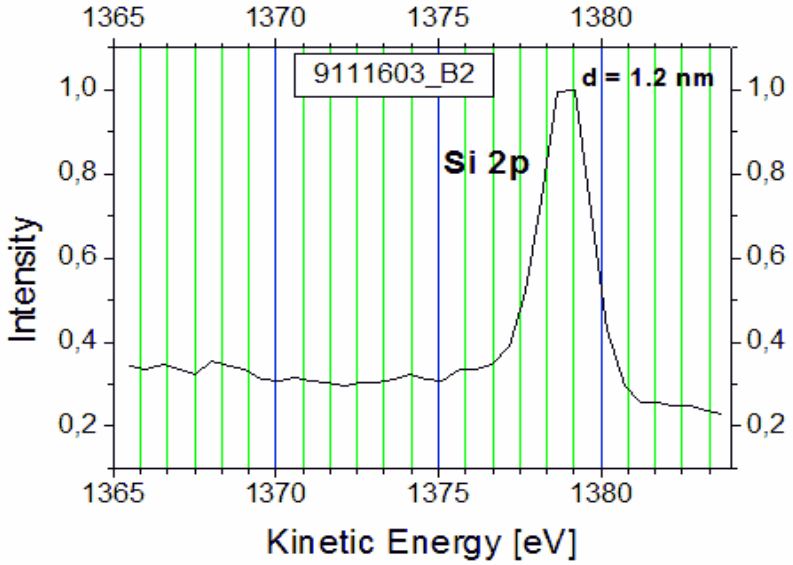
Peak	Position (eV)	Area	FWHM (eV)
0	23.460	17.195	0.500
1	23.796	57.155	0.500
2	24.143	45.976	0.500
3	24.557	17.763	0.500

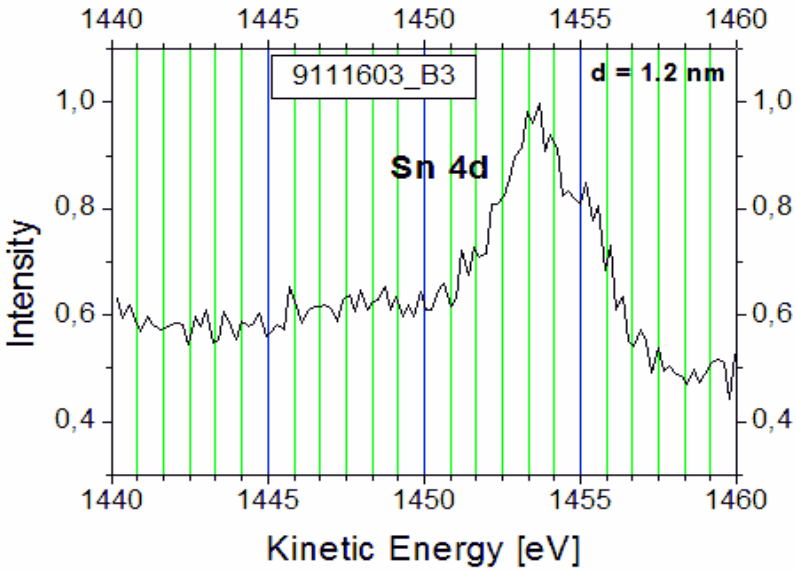
D(041,1999)

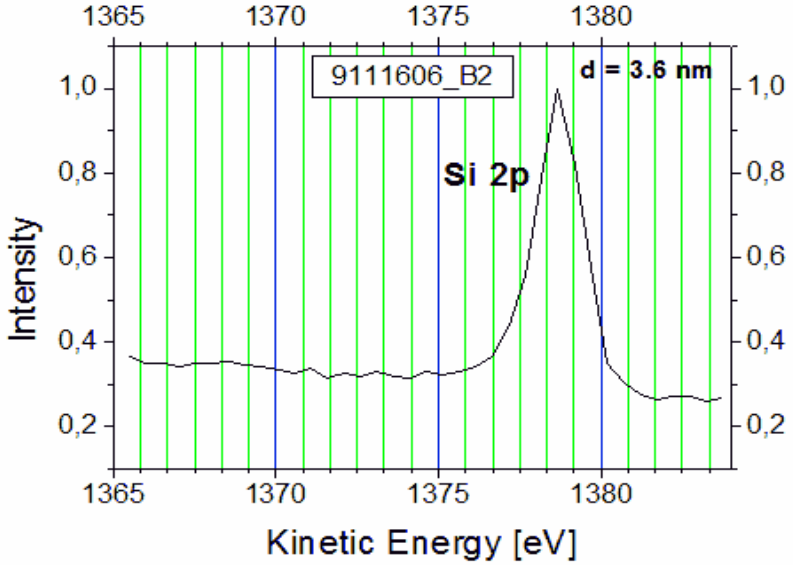
Peak	Position (eV)	Area	FWHM (eV)
0	23.493	20.767	0.500
1	23.846	53.631	0.500
2	24.209	47.861	0.500
3	24.604	18.671	0.500

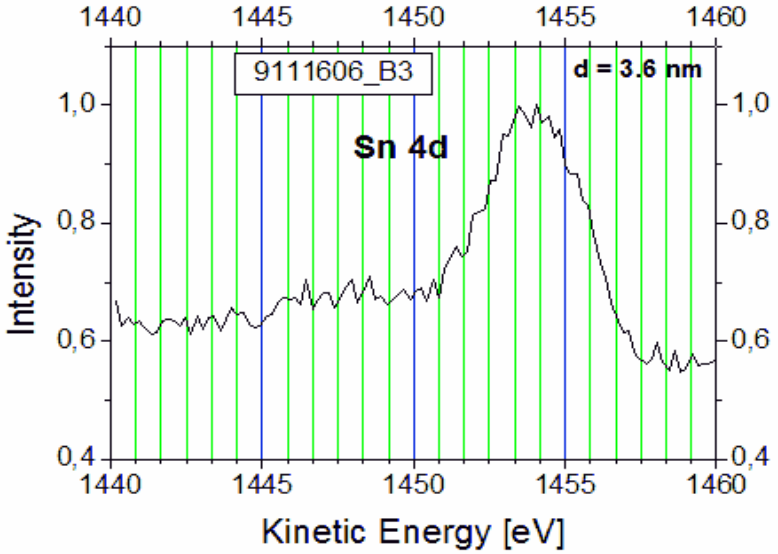
E(040,1999)

Peak	Position (eV)	Area	FWHM (eV)
0	23.490	24.512	0.500
1	23.866	47.515	0.500
2	24.234	41.769	0.500
3	24.641	15.690	0.500


9111603_B2
d = 1.2 nm
Si 2p
Intensity
Kinetic Energy [eV]

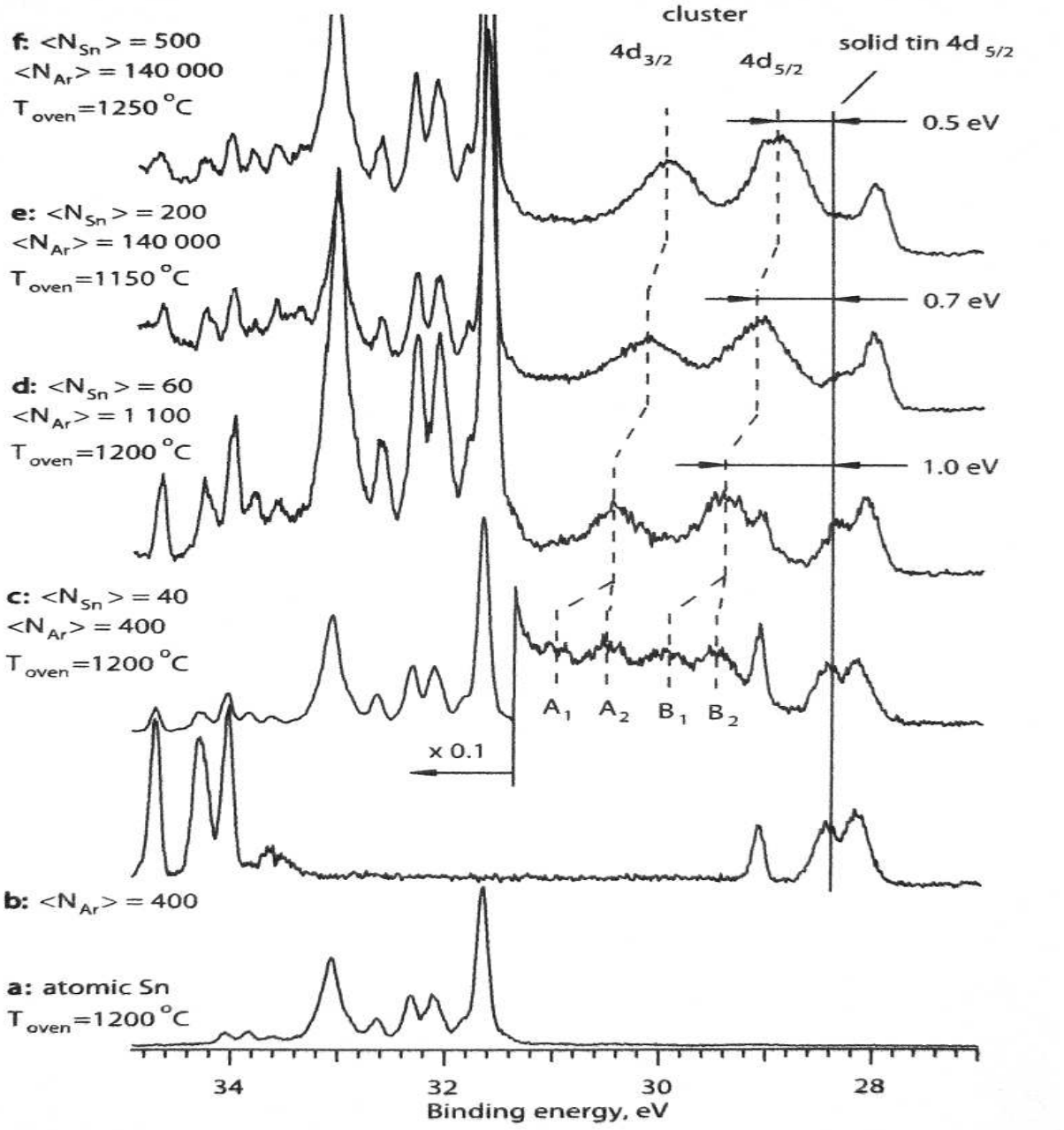

9111603_B3
d = 1.2 nm
Sn 4d
Intensity
Kinetic Energy [eV]


9111606_B2
d = 3.6 nm
Si 2p
Intensity
Kinetic Energy [eV]


9111606_B3
d = 3.6 nm
Sn 4d
Intensity
Kinetic Energy [eV]

• Mi lehet és mi nem? (Nincs oxid és nincs más kémiai összetevő => nincs kémiai reakció.)

Akkor mi?!?



Spectra of tin and argon clusters. Experimental settings are shown for each spectrum. The Ar cluster peak in the binding energy region of 14 eV was chosen for intensity calibration of the spectra.

Sn lehetséges állapotai a Si mátrix felületén

interstíciális	klaszter	szegregált	subsztituciós
---	---	---	---

<== kötési energia

Itt is nanovilág van…