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NOTE

SIMPLE AND ACCURATE REPRESENTATION OF IMPLANTATION PARAMETERS BY LOW ORDER POLYNOMALS

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INTRODUCTION

Ion implantation is an indispensable step in the process of producing modern integrated circuits. Thereby, in particular in silicon technology, the elements B, P, As and Sb are implanted. By the implantation process gausshape profiles are generated[1–4]. In practice such profiles are characterized by the projected range (R_p) and the projected standard deviation (ΔR_p). These parameters are fairly complicated functions of the implantation energy (E), the element, the substrate and other physical parameters. For the practical performance of ion implantation the values R_p and ΔR_p being dependent on energy are listed in tables for various materials and elements. The values are deduced from theory as well as from experiments[3, 5].

A considerable disadvantage of such tables is that they are unhandy. Furthermore, one has to interpolate between values. Introducing such tables in numerical implantation programs precious memory space is wasted. Moreover the interpolation requires additional calculations.

This note intends to find simple functions of R_p and ΔR_p in dependence of the implantation energy in order to eliminate the above mentioned disadvantages.

The values of R_p and ΔR_p of B, As, P and Sb in Si, SiO_2 and Si_3N_4 are approximated by the following polynomals

$$R_p = \sum_{i=1}^{N_1} (A1)\, i\, E^i$$

$$\Delta R_p = \sum_{i=1}^{N_2} (A2)\, iE^i.$$

Tables 1–3 give the coefficients of the polynomals for various elements and substrates.

From the practical point of view the representation of R_p and ΔR_p by the above polynomals is more accurate and simpler than by tables.

The accuracy R_p and ΔR_p if calculated by polynomals is better than 10% in an energy range between 10 and 300 keV. These polynomals may also be inserted in computer programs with minimal expense, and intermediate values may be gained directly without interpolation.

Table 1. Coefficient (Al)*i* and (A2)*i* of the polynomals for the elements As, B, P and Sb in silicon

	As/Si		B/Si	
i	(A1)i	(A2)i	(A1)i	(A2)i
1	9.818E- 4	3.652E- 4	3.338E- 3	1.781E- 3
2	-1.022E- 5	-3.820E- 6	-3.308E- 6	-2.086E- 5
3	9.067E- 8	3.235E- 8		1.403E- 7
4	-3.422E-10	-1.202E-10		-4.545E-10
5	4.608E-13	1.601E-13		5.525E-13

	P/Si		Sb/Si	
i	(A1)i	(A2)i	(A1)i	(A2)i
1	1.259E- 3	6.542E- 4	8.887E- 4	2.674E- 4
2	-2.743E- 7	-3.161E- 6	-1.013E- 5	-2.885E- 6
3	1.290E- 9	1.371E- 8	8.372E- 8	2.311E- 8
4		-2.252E-11	-3.056E-10	-8.310E-11
5			4.028E-13	1.084E-13

Table 2. Coefficients (Al)*i* and (A2)*i* of the polynomals for the elements As, B, P and Sb in SiO_2

	As/SiO_2		B/SiO_2	
i	(A1)i	(A2)i	(A1)i	(A2)i
1	7.806E- 4	2.637E- 4	3.258E- 3	1.433E- 3
2	-7.899E- 6	-2.762E- 6	-2.113E- 6	-1.077E- 5
3	7.029E- 8	2.373E- 8		4.190E- 8
4	-2.653E-10	-8.899E-11		-6.000E-11
5	3.573E-13	1.193E-13		

	P/SiO_2		Sb/SiO_2	
i	(A1)i	(A2)i	(A1)i	(A2)i
1	9.842E- 4	4.591E- 4	7.200E- 4	2.018E- 4
2	2.240E- 7	-1.983E- 6	-8.054E- 6	-2.328E- 6
3		8.383E- 9	6.641E- 8	1.917E- 8
4		-1.382E-11	-2.422E-10	-6.997E-11
5			3.191E-13	9.211E-14

Table 3. Coefficients (Al)*i* and (A2)*i* of the polynomals for the elements As, B, P and Sb in Si_3N_4

	As/Si_3N_4		B/Si_3N_4	
i	(A1)i	(A2)i	(A1)i	(A2)i
1	6.094E- 4	2.035E- 4	2.514E- 3	1.115E- 3
2	-6.213E- 6	-2.092E- 6	-1.618E- 6	-8.328E- 6
3	5.516E- 8	1.787E- 8		3.228E- 8
4	-2.080E-10	-6.678E-11		-4.612E-11
5	2.799E-13	8.932E-14		

	P/Si_3N_4		Sb/Si_3N_4	
i	(A1)i	(A2)i	(A1)i	(A2)i
1	7.617E- 4	3.542E- 4	5.660E- 4	1.516E- 4
2	1.681E- 7	-1.488E- 6	-6.440E- 6	-1.655E- 6
3		6.204E- 9	5.323E- 8	1.345E- 8
4		-1.019E-11	-1.944E-10	-4.878E-11
5			2.563E-13	6.401E-14

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