UDC 53.072; 53:681.3

[2]T.A. Shmygaleva*, [2]Sh.E. Jeleunova, [2]A.A. Kupchishin, [1,3]A.I. Kupchishin, [2]E.V.Smygalev

[1]Institute of New Chemical Technologies and Materials, Kazakhstan, Almaty
[2]al-Farabi Kazakh National University, Kazakhstan, Almaty
[3]Abai Kazakh National Pedagogical University Kazakhstan, Almaty
*E-mail: Shmyg1953@mail.ru

Generation of radiating defects in the copper irradiated by ions of aluminum

Processes of radiation formation of defects in the copper irradiated by ions of aluminum are considered in the work. Algorithms of calculation of concentration of radiating defects are developed, presented in the form of block diagrams. The regularities of behavior of concentration of cascade areas in the copper irradiated by aluminum are revealed. Results of calculations are presented in the form of charts and tables.
Key words: electrogenerators, copper, contact wires, radiators, bearings, aluminum.

Т.А. Шмыгалева. Ш.Е. Желеунова, А.А. Купчишин, А.И. Купчишин, Е.В. Шмыгалев,
Алюминий иондарымен сәулелендірілген мыстағы радиациялық дефект генерациясы

Бұл жұмыста алюминий иондарымен сәулендірілген мыстың радияциялық дефект түзілу үдерістері қарастырылған. Радиациялық дефектілердің концентрацияларының есептеу алгоритмдері жасалып, блок-сызбанұсқа түрінде келтірілген. Алюминиймен сәулелендірілген мыстың каскадты аймақтарының концентрацияларының өзгеру зандылықтары анықталған. Есептеу нәтижелері график және кесте түрінде келтірілген.
Түйін сөздер: электрогенераторлар, мыс, контакт сымы, радиаторлар, алюминий.

Ш.Е. Желеунова, А.А. Купчишин, А.И. Купчишин, Е.В. Шмыгалев, Т.А. Шмыгалева
Генерация радиационных дефектов в меди, облученной ионами алюминия

В работе рассматриваются процессы радиационного дефектообразования в меди, облученной ионами алюминия. Разработаны алгоритмы расчета концентрации радиационных дефектов, представлены в виде блок-схем. Выявлены закономерности поведения концентрации каскадных областей в меди, облученной алюминием. Результаты расчетов представлены в виде графиков и таблиц.
Ключевые слова: электрогенераторы, медь, контактная проволока, радиаторы, алюминий.

Introduction

Copper, its connections and flotages find wide application in various industries. Copper in the electro technology is used in the pure state: in manufacture of cable products, trunks of naked and contact wires, electrogenerators, the telephone and cable equipment and radio equipment. Heat-exchangers, vacuum-devices, pipelines are made from copper. More than 30 % of copper spent on flotages. Flotages of copper with other metals are used in mechanical engineering, in the automobile and tractor industry (radiators, bearings), for manufacturing the chemical equipment. High viscosity and plasticity of metal allow to apply copper to manufacturing varied products with very complex pattern. The wire from red copper in burned condition becomes so soft and plastic, that from it without effort it is possible to twist every possible cord and to curve the most complex elements of an ornament.

Flotages on the basis of copper are considered in work, as now bunches of ions are intensively applied in mechanical engineering at reception of ultra strong details and materials. For hardening units, details and materials in mechanical engineering we develop a new in cascade - probabilistic method (CPM), in which is based on reception of analytical expressions and further use of cascade – probabilistic functions (CPF). CPF make sense probabilities that the particle generated on some depth *h'* will reach depth *h* after n-th of impacts.

Experiment

For calculation CPF the formula (159) [1] is used. The parameters of approximation entering in approximation expression, the approximating section of interoperability calculated under the Rutherford formula have been found. The regularities of selection approximation coefficient, regularities of behavior of actual area of result are found at calculation of cascade - probabilistic functions depending on number of interactions and depth of penetration of particles at various values of initial energy.

With use of the received expression for CPF concentration vacant clusters under the formula (176 [1] is calculated. The algorithm of calculation is presented in figures 1, 2. Results of calculations are resulted in tables 1, 2 and in figures 3-5.

For easy flying particles and easy targets curves increase, peaking, then decrease up to zero. With an increase of initial energy of a particle curves are displaced to the right. With an increase of threshold energy of the E_c of value of concentration decrease, and curves pass significantly below, transition through a maximum is carried out more smoothly. At energy E_0 =100 кeV the curve decreases. With an increase of nuclear weight of a flying particle value of function in a point of a maximum increases and, consequently, curves pass above while values of depths decrease. With an increase of nuclear number of a target for the same flying particles value of function in a point of a maximum slightly increases, values of depths decrease.

Results and Discussion

The finding of area of result of concentration of radiating defects at an irradiation of copper ions of aluminum has allowed to reveal following regularities:

1. With reduction of initial energy of a primary particle the interval of area of result is displaced to the right, values of concentration of radiating defects increase
2. Depending on depth of penetration initial and final values of number of interactions increase, the interval of area of result (n0 n1) also increases and displaced to the right

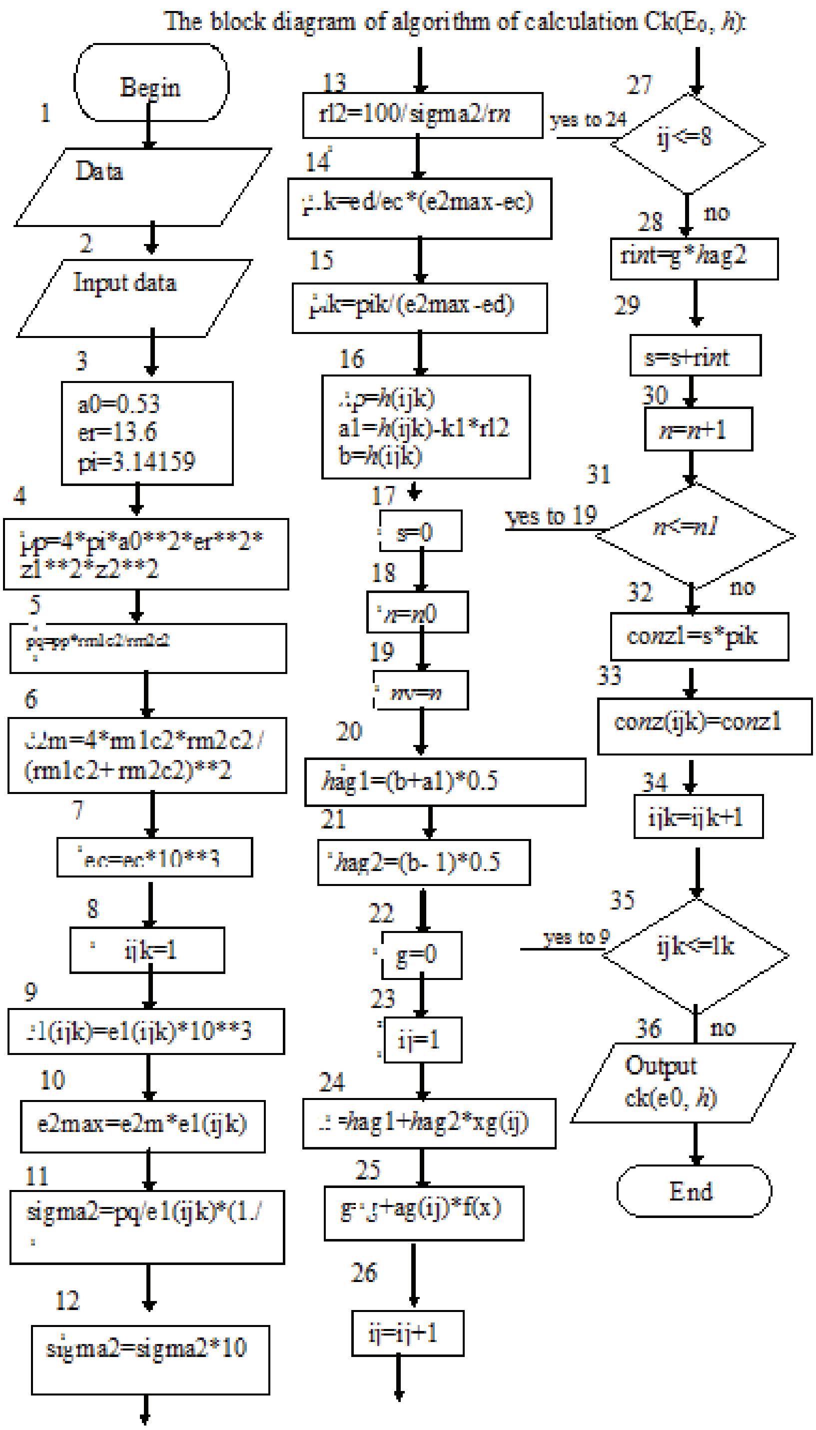

Figure 1 – The block diagram of algorithm of calculation Ck(E_0, *h*) The block diagram of calculation of subintegral function f(*h*1)

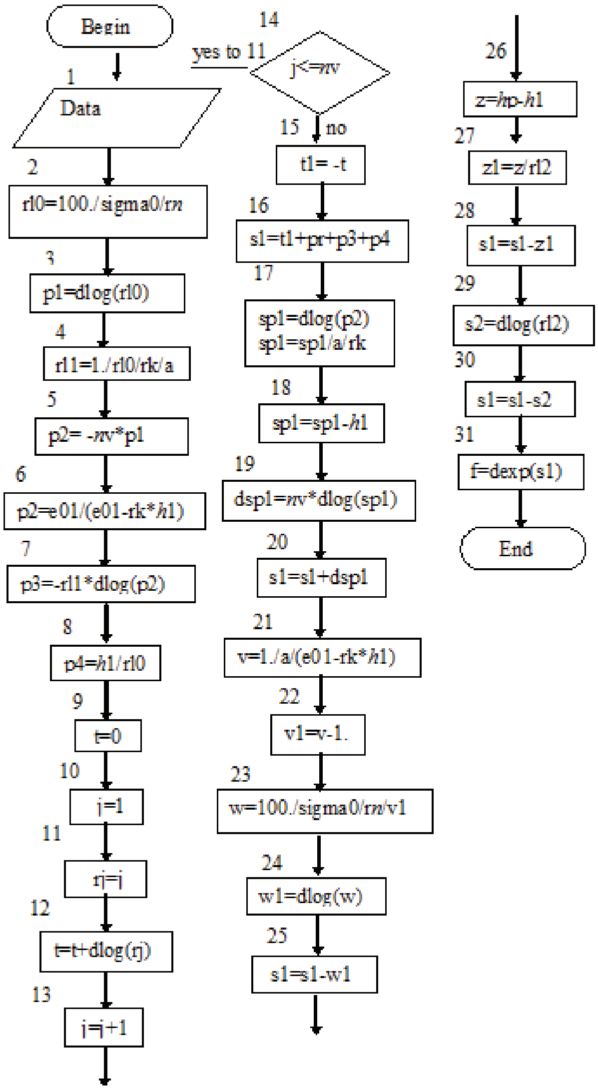

Figure 2 – The block diagram of calculation of subintegral function f(*h*1)

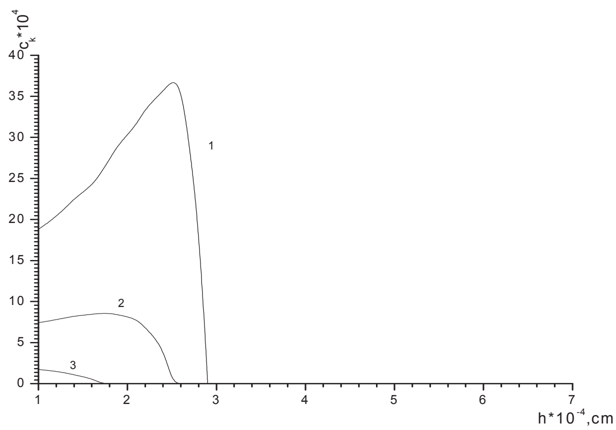

Figure 3 – Dependence of concentration of cascade areas on depth at an irradiation of copper ions of aluminium: E_0= 1000 кэВ, E_c= 50 (1), 100 (2), 200 (3) эВ

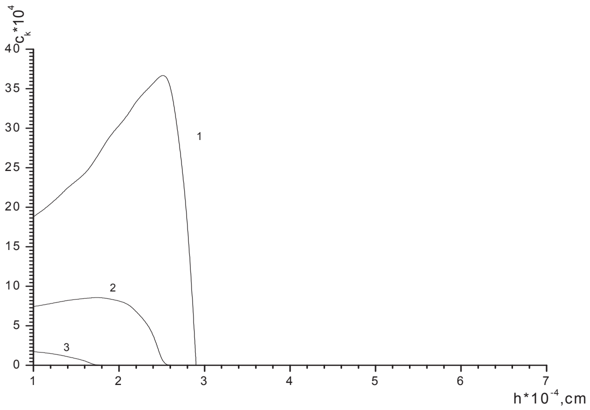

Figure 4 – Dependence of concentration of cascade areas on depth at an irradiation of copper ions of aluminum: E_0= 500 кэВ, E_c= 50 (1), 100 (2), 200 (3) эВ

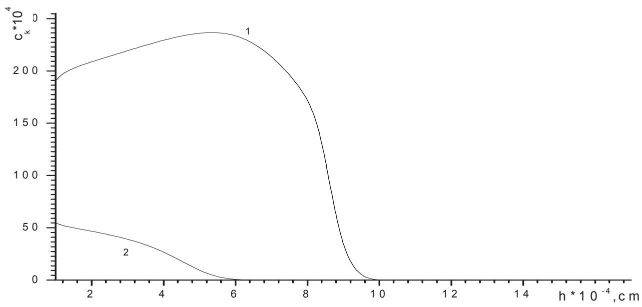

Figure 5 – Dependence of concentration of cascade areas on depth at an irradiation of copper ions of aluminum: E_0= 200 кэВ, E_c= 50 (1), 100 (2) эВ

Table 1 – Borders of a range of definition of concentration of radiating defects for aluminum in copper at E_c=50, 100, 200 кэВ, E_0= 800 кэВ

$h*10^4$,см	$C_к$	E_0, кэВ	n_0	n_1
0	4469	800	1	31
	2054			
	846			
0,6	5460	700	502	856
	2475			
	982			
1,2	6786	600	1316	1879
	3018			
	1133			
1,8	8607	500	2436	3159
	3719			
	1275			
2,5	11249	400	4006	4912
	4637			
	1331			
2,8	13011	350	5005	6028
	5166			
	1244			
3,1	15292	300	6255	7434
	5745			
	971			

Table 1

3,2	16350 5957 761	280	6818	8030
3,4	17643 6189 463	260	7502	8747
3,5	18947 6333 26	240	8200	9498
3,6	20387 6393 0	220	8947	10328
3,7	21969 6305 0	200	9803	11264
3,8	23914 6016 0	180	10838	12346
4	25747 5202 0	160	11944	13533
4,2	27524 3517 0	140	13229	14829
4,3	28849 122 0	120	14749	16466
4,4	28608 0 0	100	16592	18460
4,5	22883 0 0	80	18752	20676
4,6	15279 0 0	70	20054	22070
4,7	526 0 0	60	21575	23713

Table 2 – Borders of a range of definition of concentration of radiating defects for aluminum in copper at E_c=50, 100, 200 кэВ, E_0= 200 кэВ

$h*10^4$,см	$C_к$	E_0, кэВ	n_0	n_1
0	19051	200	7	109
	5468			
	0			
0,13	20165	180	614	1013
	5073			
	0			
0,26	21486	160	1464	2049
	4341			
	0			
0,4	23011	140	2556	3327
	2940			
	0			
0,53	23929	120	3775	4665
	101			
	0			
0,65	23168	100	5136	6182
	0			
	0			
0,78	18776	80	6996	8189
	0			
	0			
0,84	14783	70	9275	10664
	0			
	0			
0,9	525	60	10752	12257
	0			
	0			

Conclusion

Thus, in this paper the algorithms for calculating the concentration of radiation-induced defects have been obtained and presented in the form of block diagrams. The calculations of concentration of radiation defects in copper irradiated with aluminum ions were given. It were found the regularities of the behavior of the domain of definition, depending on the initial energy of the primary particle, the depth of penetration of the threshold energy.

References

1. Kupchishin A.A., Kupchishin A.I., Shmygaleva T.A., etc. Modelling on the PC and experimental researches of radiating processes in iron and firm flotages. The monography. Almaty. – 2010 – p. 263.