

621.315.592

-

...” ...” , ...” , ...” ,  
 \* ...” , ...” , ...” ,  
 ...” , ...” , ...”

\* - , ..

**1.** \_\_\_\_\_ -

[1,2]. -

2030 . -

.1.

1.

**2030 .**

			-
		,	o
2010	1700	1500	250
2015	25500	22500	3750
2020	51000	50000	7500
2025	71000	62500	10400
2030	113400	100000	17000

[3-5].

(Ge, CuInSe<sub>2</sub>, GaAs, CdTe)  
 (SG),

(MG)

(EG)

SG-

MG-  
 [6],

SG-

---

2.

---

[3-8]

SG -

SG-

3.

---

4.

---

MG- 100

$10^{-2}$

.2.

, (.2),

Ti, Al, S, P, C

20%..

« » (.1).

-21,

Cu-K  
( )

JEOL TECHNICS.

## MG-Si

	% ( )		%
	mg-Si	mg-Si	
Cu	0,016	0,002	87,5
Al	0,21	0,055	73,8
Ca	0,26	0,13	50
Fe	1	0,8	20
P	0,006	0,005	17
S	0,02	0,001	95
C	0,12	0,015	87,5
Cr	0,066	0,044	33
Ti	0,32	0,032	90
-	2,018	1,084	46,31
Si	97,982	98,916	-



.1.

(HNO<sub>3</sub> + HF).

7\ 2.

( .2).

6-

. 3.

( .3, )

-1

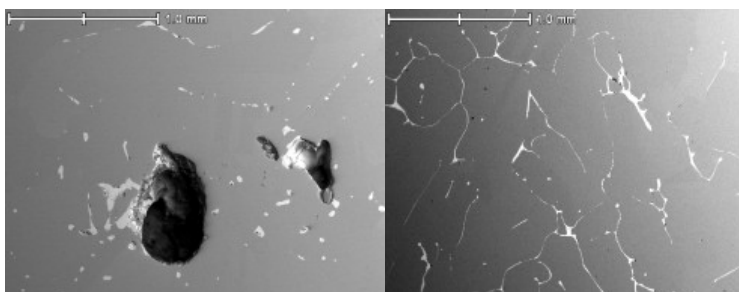
2,

,

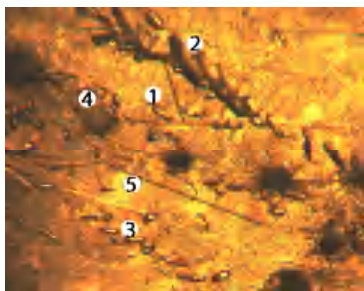
4,

5.

3,



2. - , -  
 - , . 50 -  
 , 1 2- 2.  
 , ,

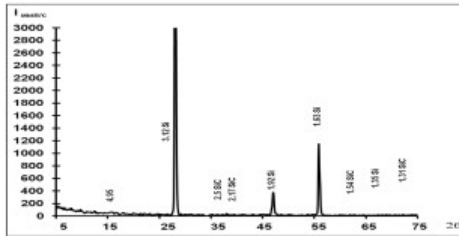
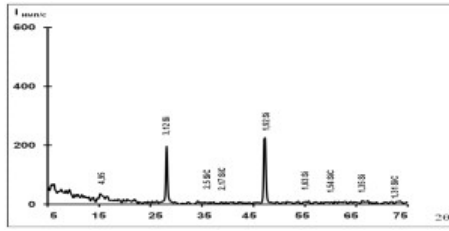


3. : - , -  
 , 200 -

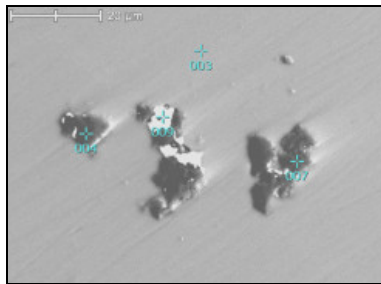
=4,95). : Si, SiC (d<sub>hkl</sub>)

JEOL TECHNICS

4. 10-20 , -  
 , - SiC. -



3. ; -



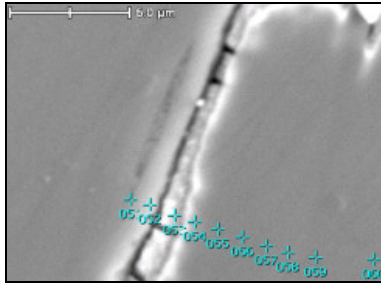
x1500

	C	Al	Si	Ca	Cr	Fe	,%
003			100.0				100
004	14.12	1.54	81.70	2.64			100
007	13.78	1.19	83.47	1.55			100
009		1.39	41.16		1.23	56.22	100

4. 1, ; -

Si -

( ) ( .5).  
 .5, FeSi FeSi<sub>2</sub>, -  
 , .3, .



x8000

	Al	Si	Ca	Fe	Ni	,%
051		100.0				100
052	1.14	98.86				100
053	12.47	44.79	5.39	35.28	2.08	100
054	12.33	54.29	4.96	26.95	1.47	100
055	6.09	81.33	2.36	10.22		100
056	2.35	94.53		3.11		100
057	0.93	99.07				100
058	0.67	99.33				100
059	0.54	99.46				100
060		100.0				100

.5.

\_\_\_\_\_ ;  
 50% Cu -  
 87,6%, Al -73,8%, S- 95%, C- 87,5%, Ti -90%,

0,2-2,0

---

: Ca, Cr, Fe, Ni, Al

Fe, Al, Cr, Ni

Ca,

SG-

1. 20.02.2003 555-IV "
2. 08.10.2008 1317-  
( - "
3. US Patent 5,961,944. Aratani et al. Process and apparatus for manufacturing polycrystalline silicon, and process for manufacturing silicon wafer for solar cell. Oct.5,1999.
4. Yuge N., Hanazawa K., Kato Y. Removal of Metal Impurities in Molten Silicon by Directional moldification with Electron Beam Heating // Materials Transactions. – 2004. – Vol. 45. – N 3. – . 850 – 857.
5. US Patent 0123947. Yamauchi et al. Method and apparatus for refining boron-containing silicon using an electron beam. Jun. 15, 2006.
6. / . . . //
7. . 1992. - 408 .
8. // . – 2008. – 2. – .69 – 73.
9. . . . - .  
- : , 1997. – 264 .