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FIG. 1

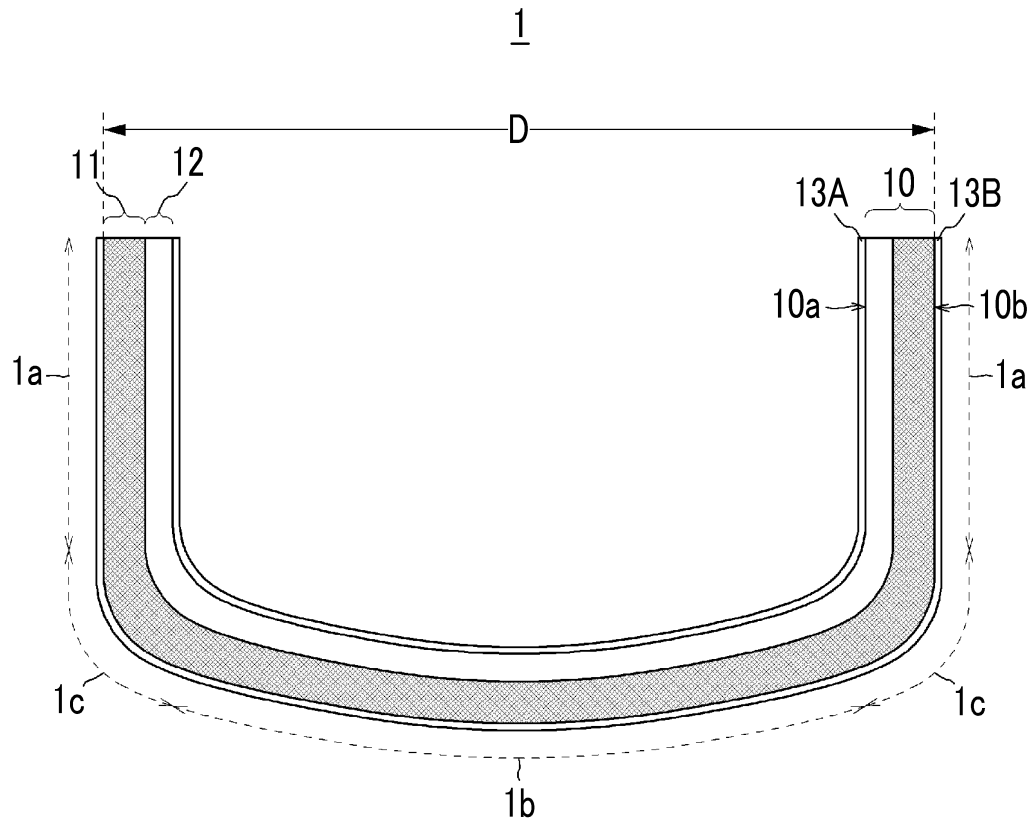


FIG. 2

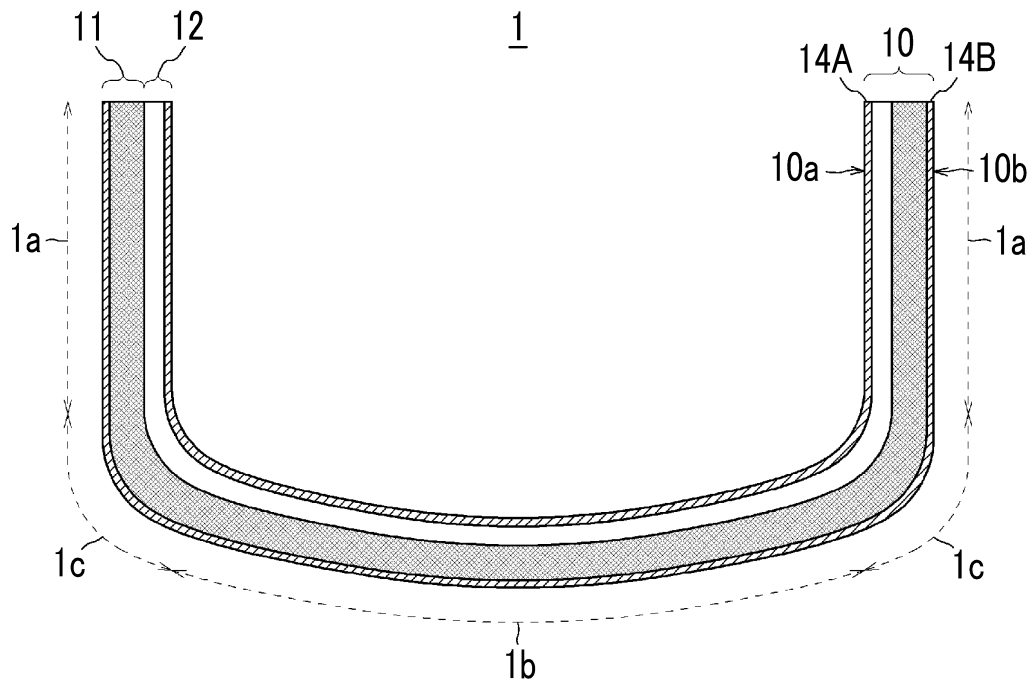
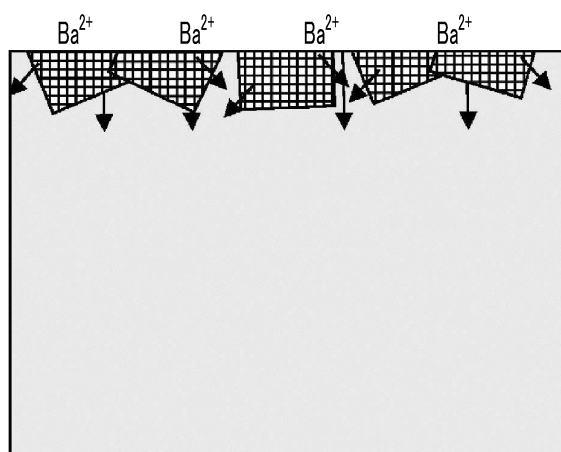
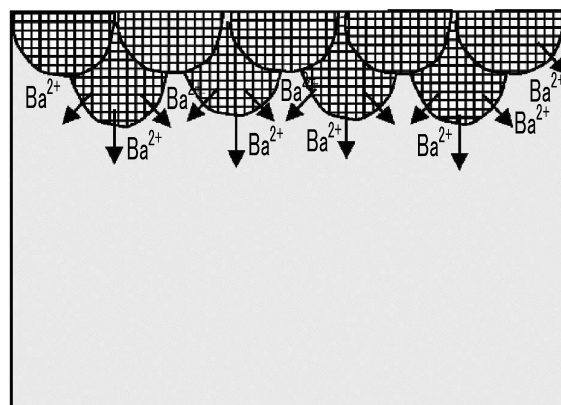


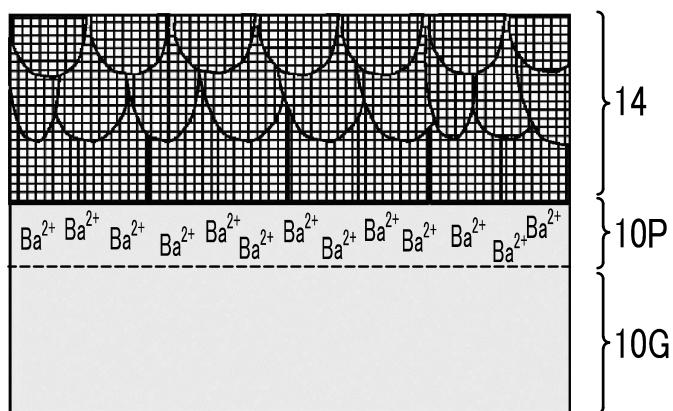
FIG. 3



(a)



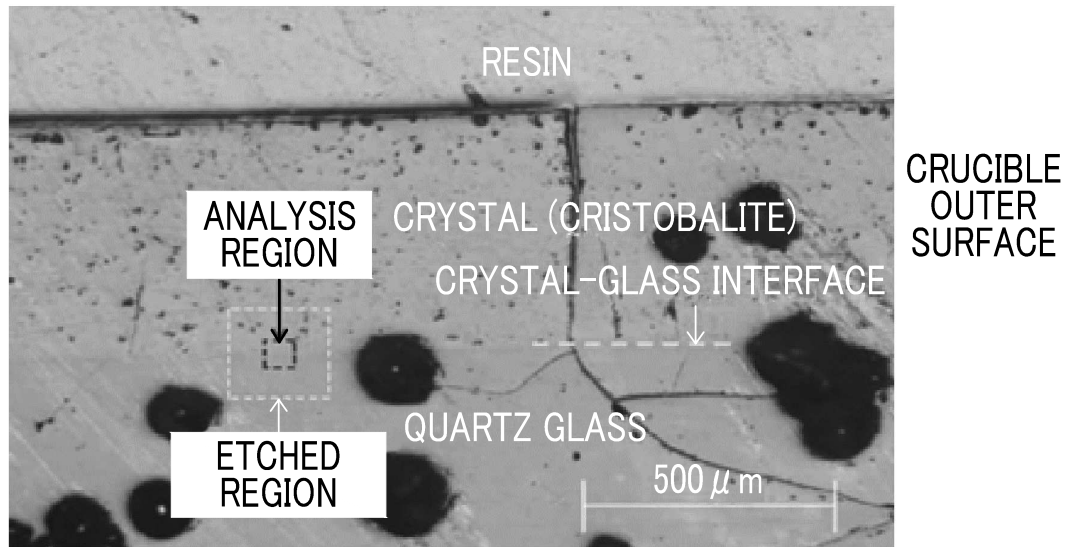
(b)



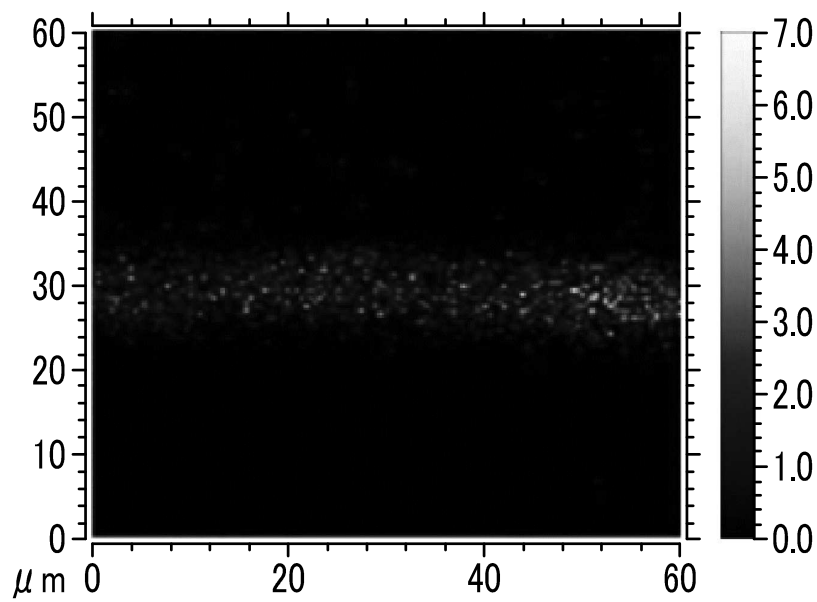
(c)

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FIG. 4



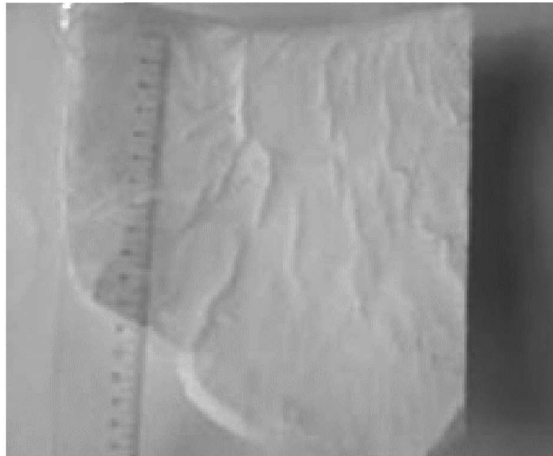
(a)



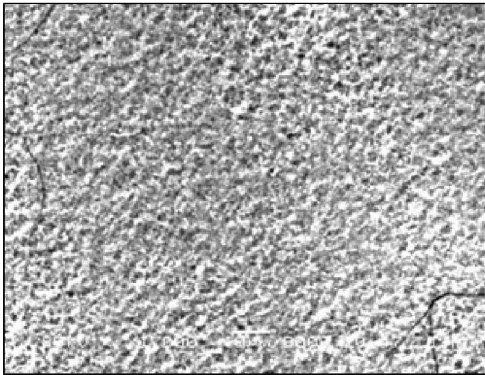
Ba⁺
MC: 7; TC: 2.248e+003

(b)

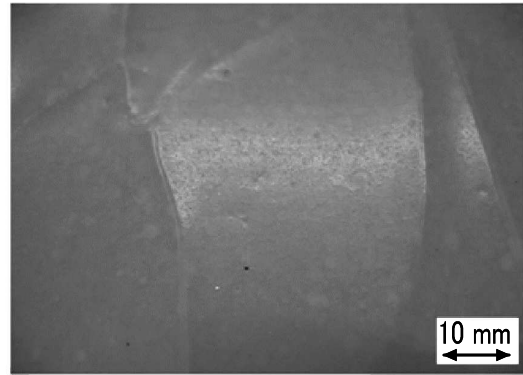
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FIG. 5



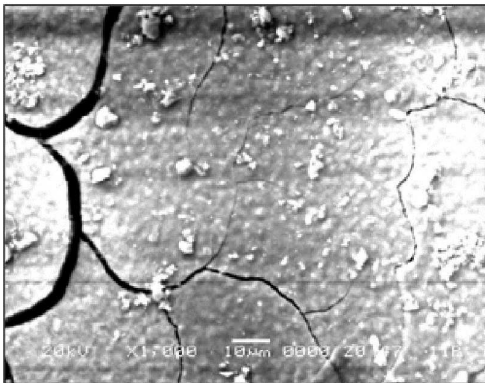
(a)



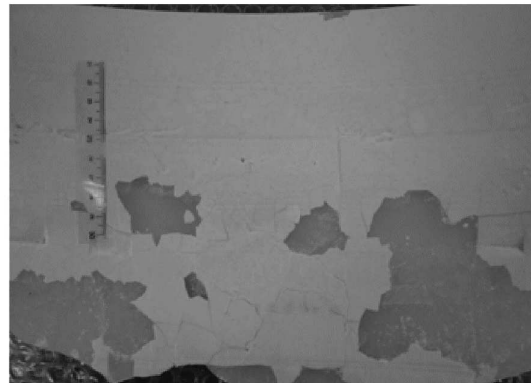
(b)



(c)

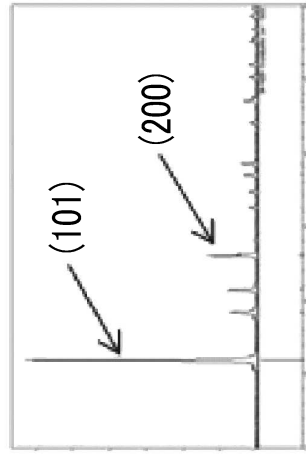


(d)



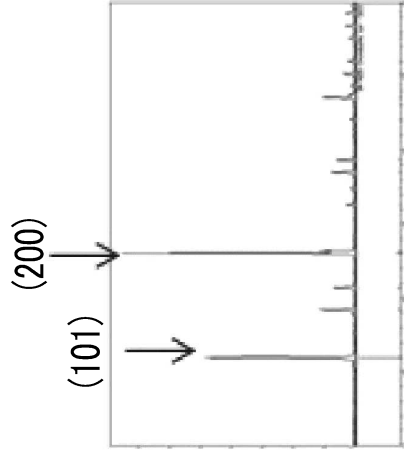
(e)

FIG. 6



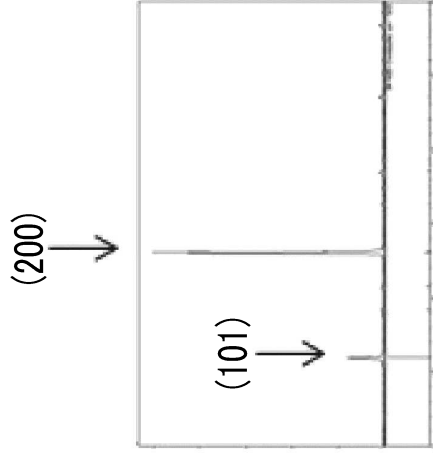
RANDOM GROWTH

(a)



GROWTH IN
DOME-SHAPED ORIENTATION

(b)



GROWTH IN
COLUMNAR ORIENTATION

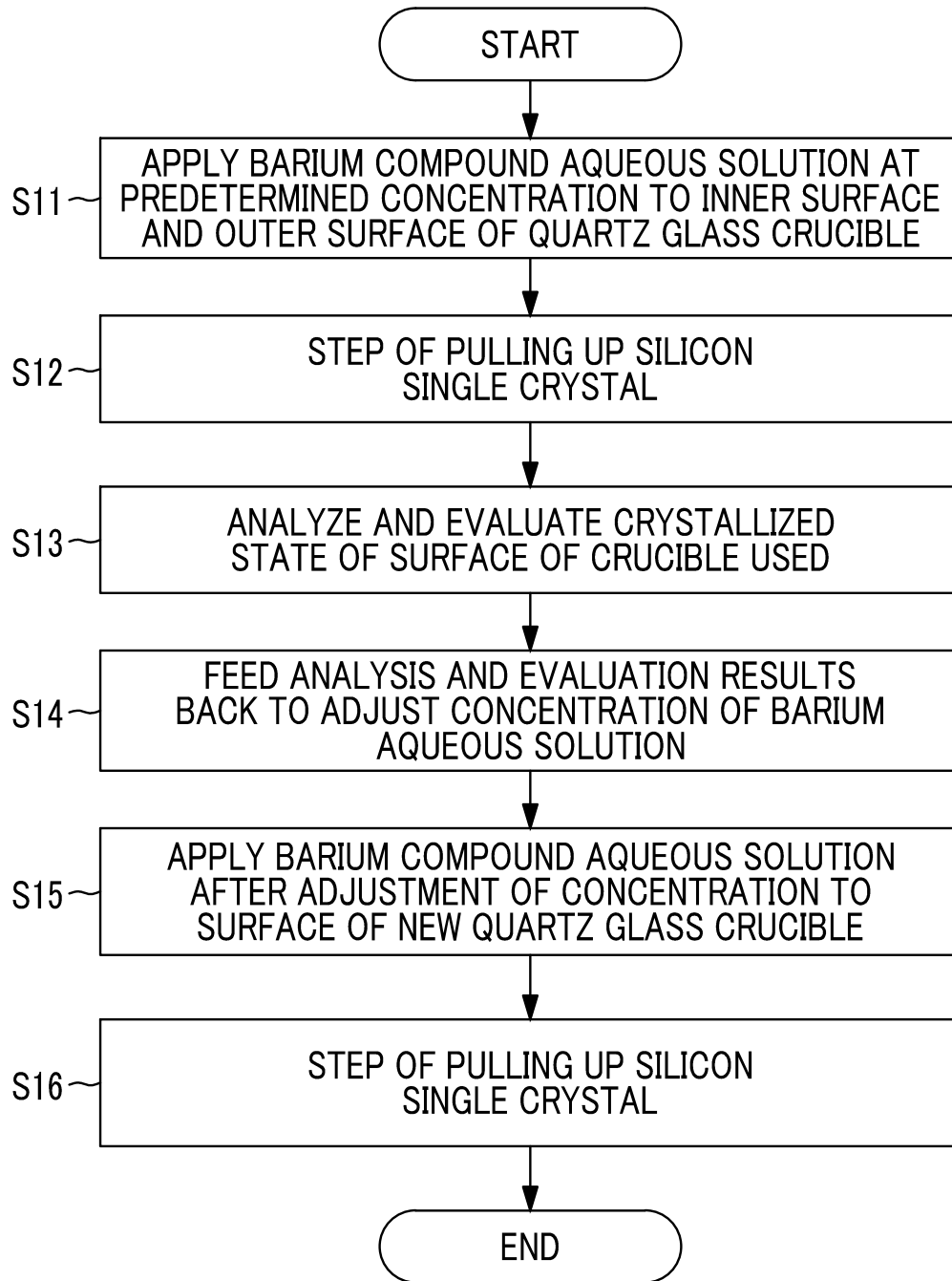
(c)

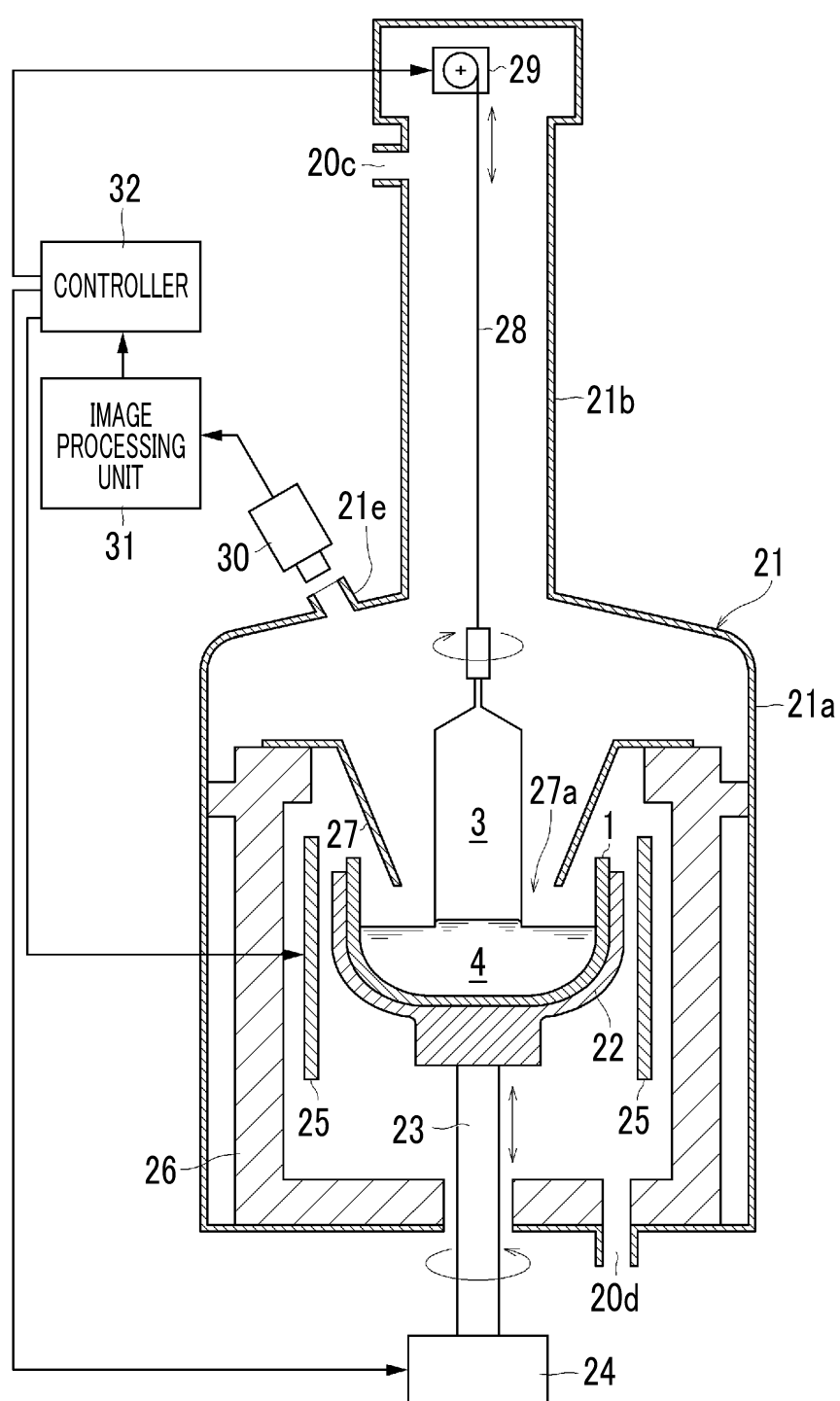
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FIG. 7

CRYSTAL STRUCTURE	CRUCIBLE					
	INNER SURFACE			OUTER SURFACE		
	W PORTION	R PORTION	B PORTION	W PORTION	R PORTION	B PORTION
RANDOM (7.0 OR MORE)	C	C	C	C	C	C
DOME-SHAPED (0.4 OR MORE AND LESS THAN 7.0)	A	B	B	A	A	A
COLUMNAR (LESS THAN 0.4)		A	A	B	B	B

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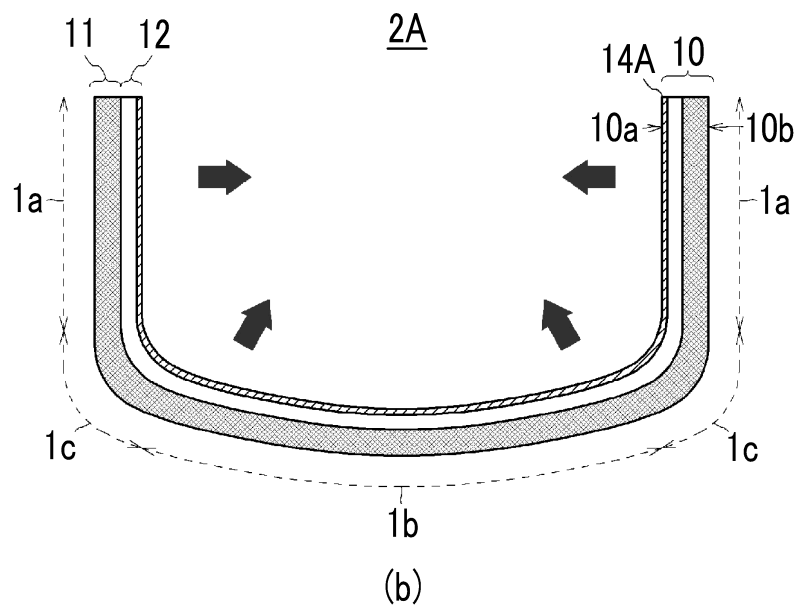
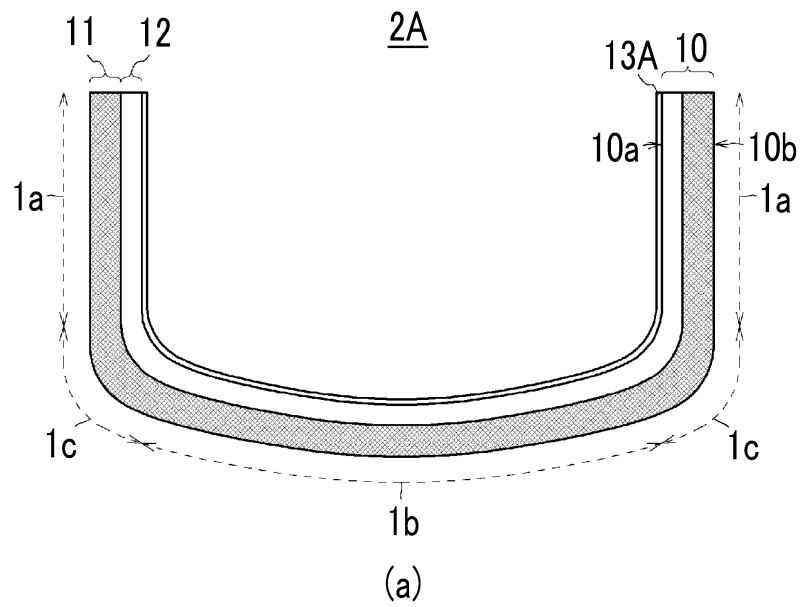
FIG. 8



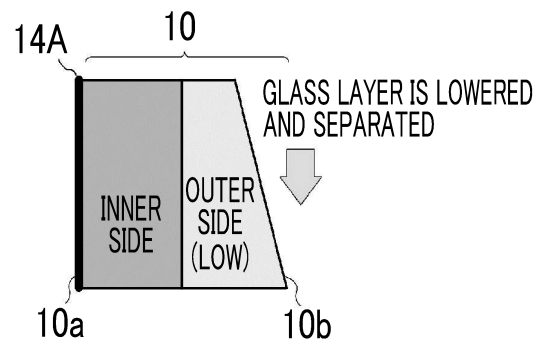
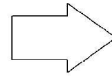
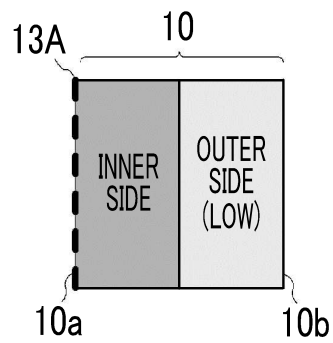


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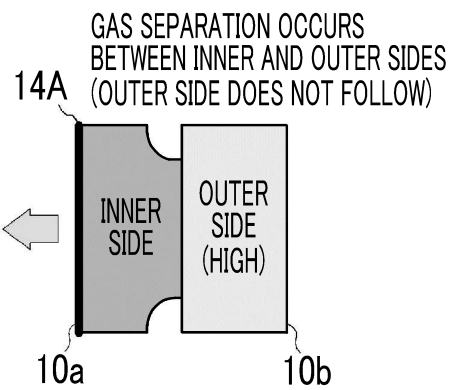
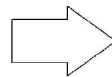
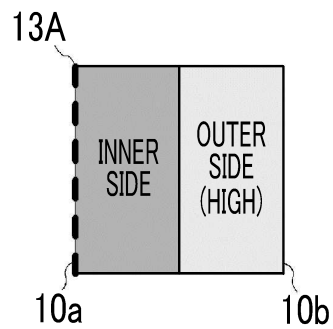
FIG. 10



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FIG. 11

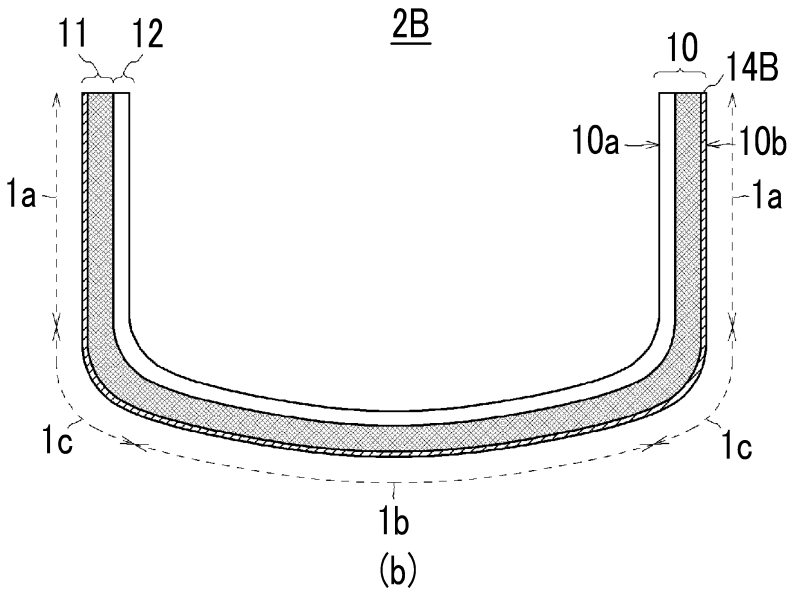
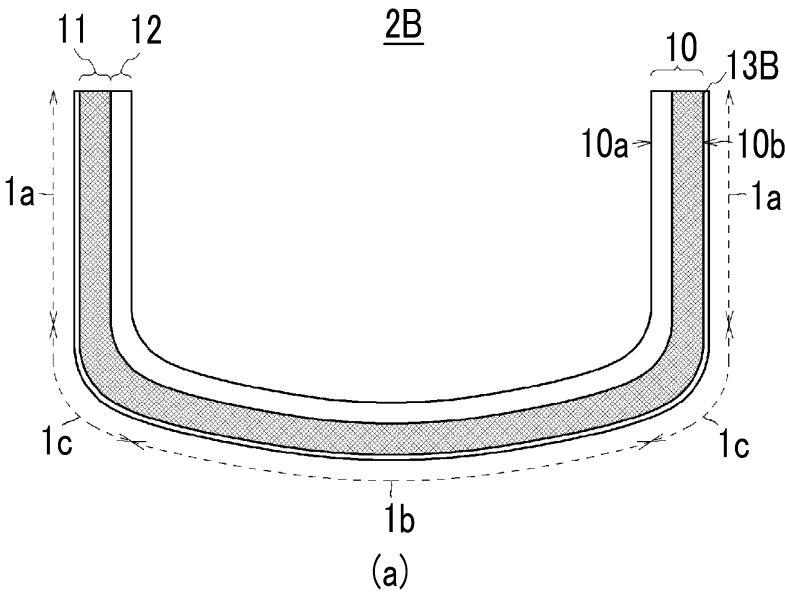


(a)



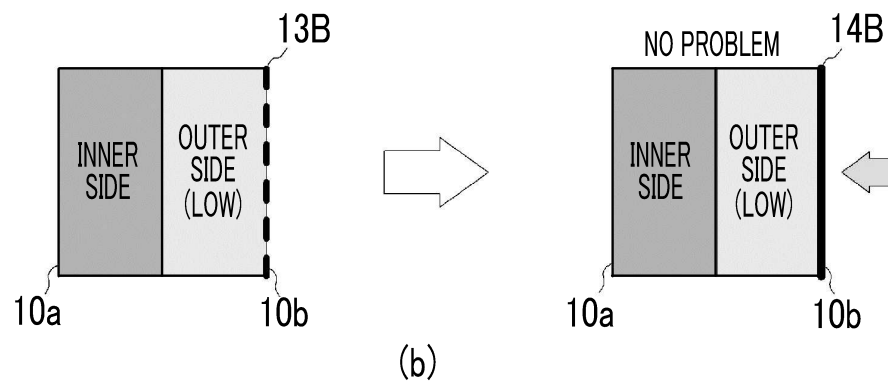
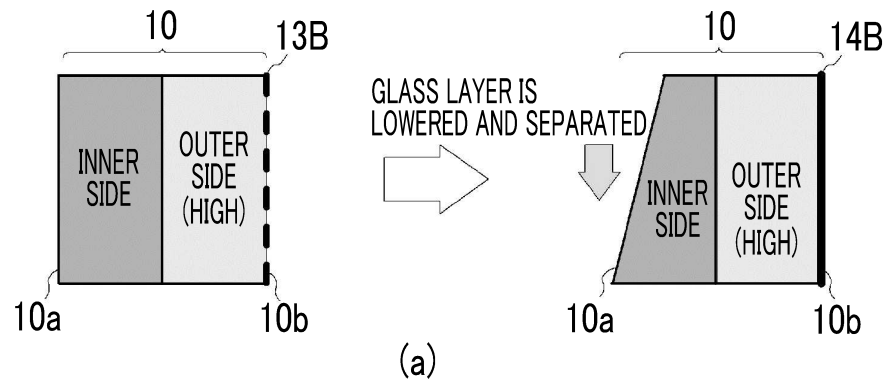
(b)

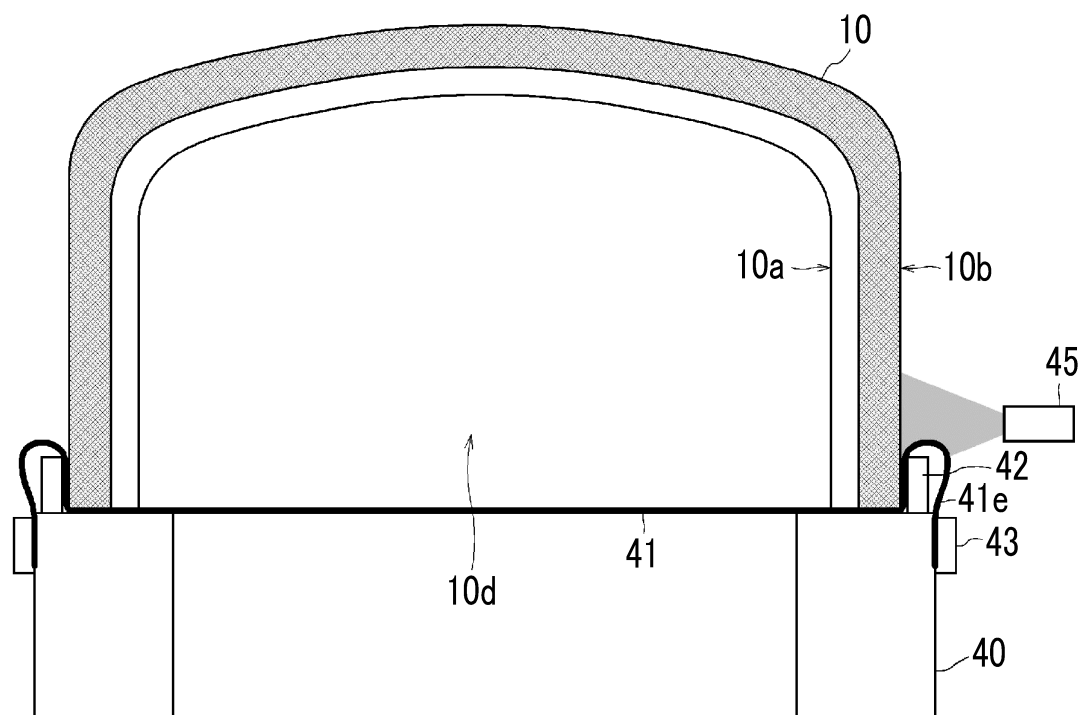
FIG. 12



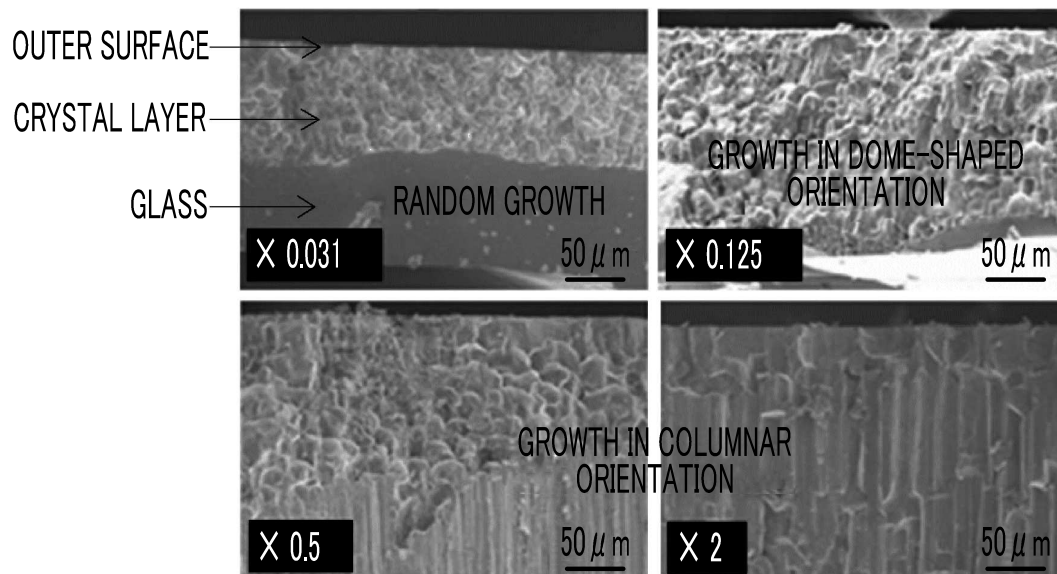
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FIG. 13

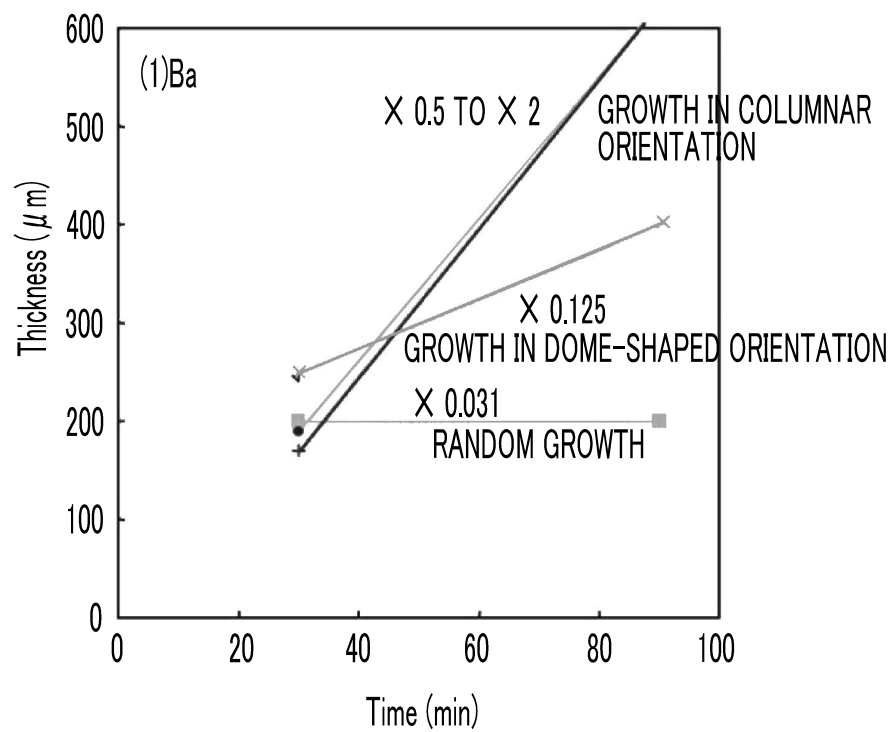




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FIG. 16



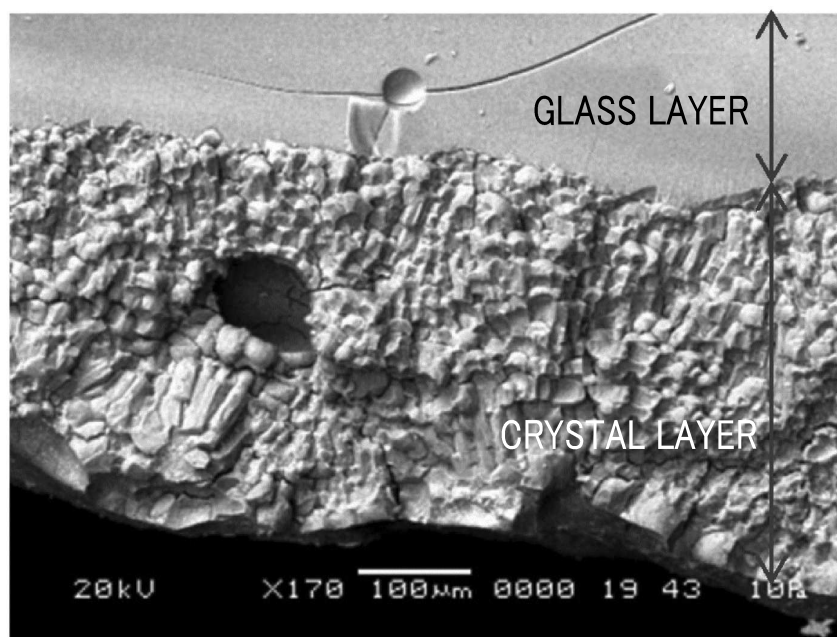
(a)



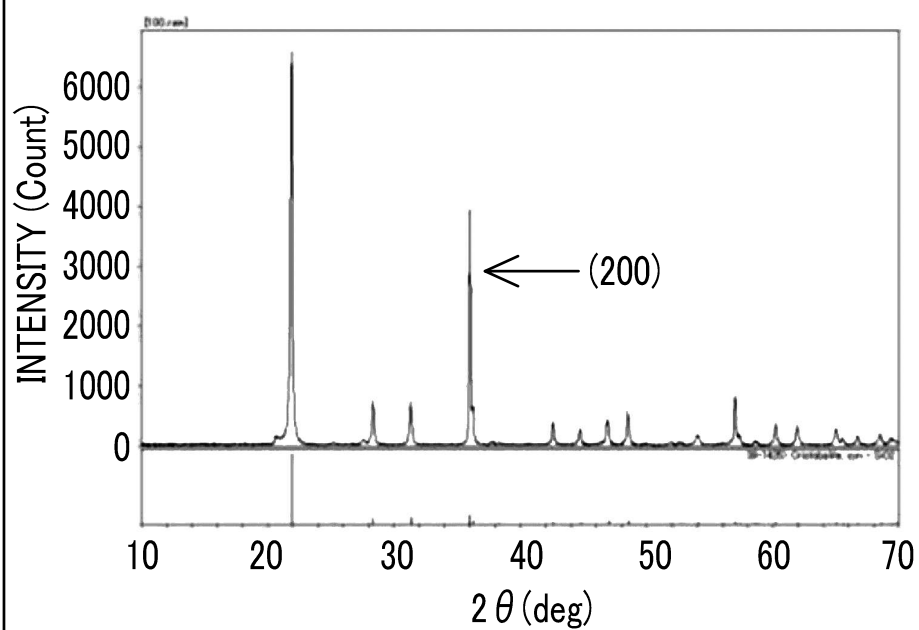
(b)

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FIG. 17

CRUCIBLE SAMPLE #1



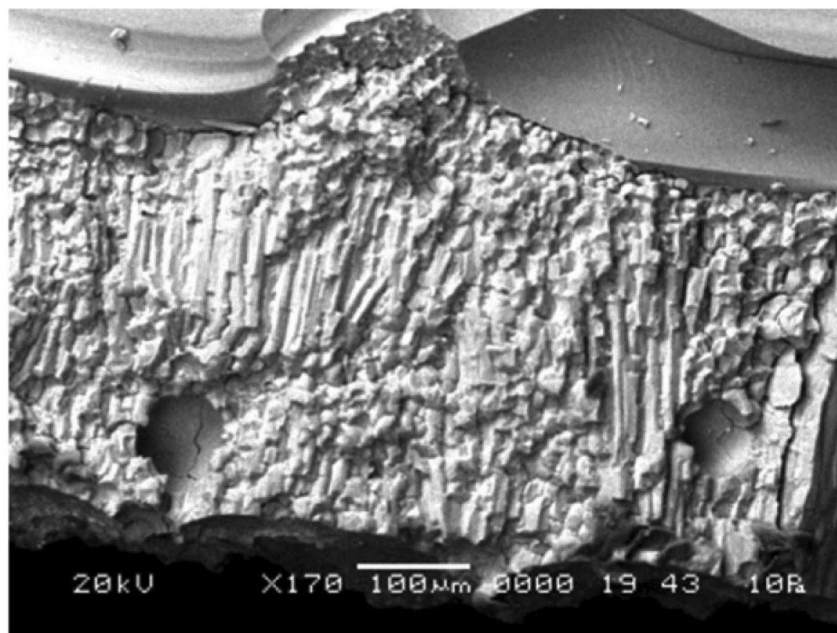
(a)



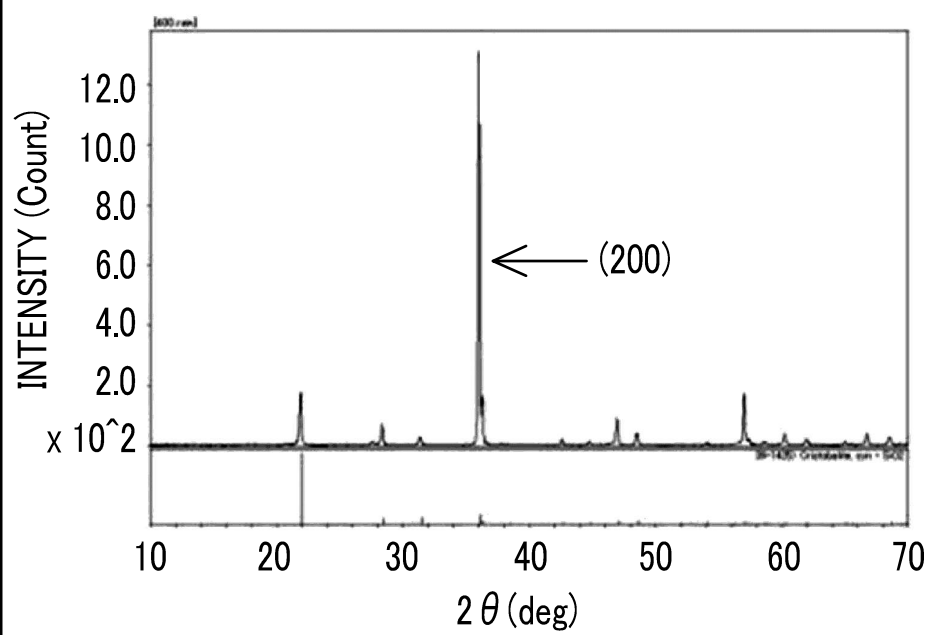
(b)

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FIG. 18

CRUCIBLE SAMPLE #2



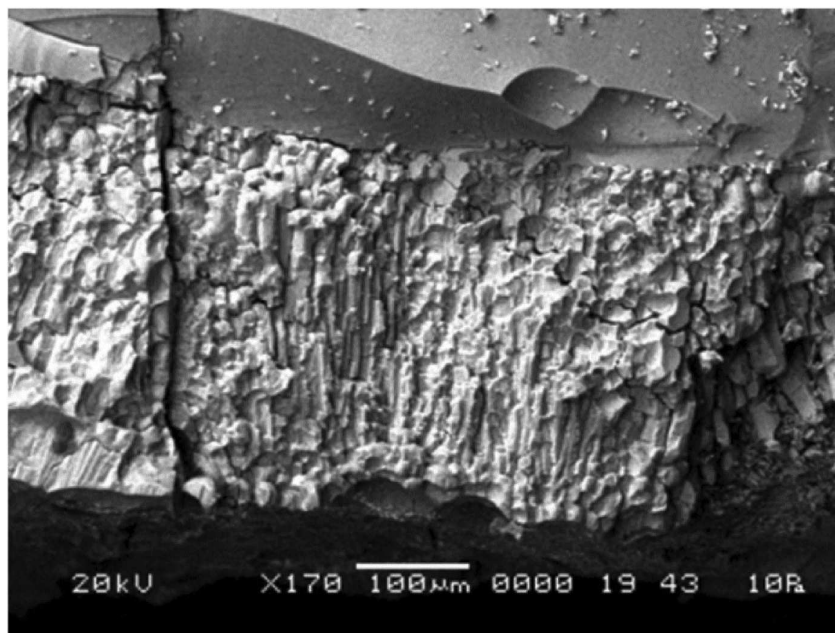
(a)



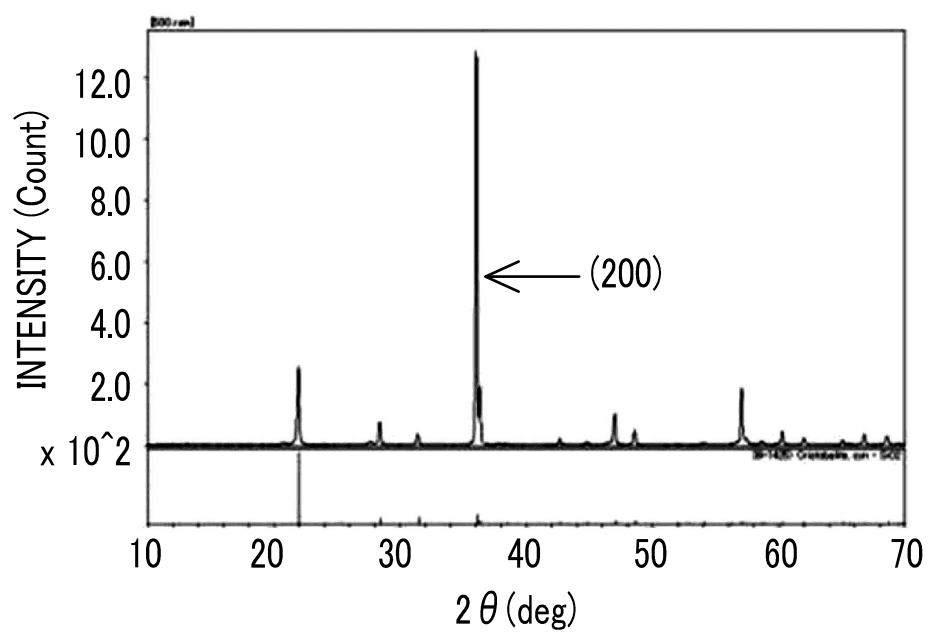
(b)

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FIG. 19

CRUCIBLE SAMPLE #3



(a)



(b)

FIG. 20

SAMPLE	X1	X2	X3	X4	X5	X6
CRYSTAL LAYER POSITION	INNER SURFACE + OUTER SURFACE	INNER SURFACE + OUTER SURFACE	INNER SURFACE + OUTER SURFACE	INNER SURFACE + OUTER SURFACE	INNER SURFACE + OUTER SURFACE	INNER SURFACE + OUTER SURFACE
INNER SURFACE APPLICATION FILM Ba CONCENTRATION (atoms/cm ²)	1.0E17	8.0E15	1.0E17	8.0E15	2.4E17	6.0E15
INNER SURFACE CRYSTAL ORIENTATION	DOME-SHAPED + COLUMNAR	DOME-SHAPED	DOME-SHAPED + COLUMNAR	DOME-SHAPED	DOME-SHAPED + COLUMNAR	DOME-SHAPED
INNER CRYSTAL LAYER THICKNESS GRADIENT	0.8 TO 1.2	0.8 TO 1.2	0.8 TO 1.2	0.8 TO 1.2	0.8 TO 1.2	0.8 TO 1.2
INNER SURFACE Ba CONCENTRATION GRADIENT	70 TO 130%	70 TO 130%	70 TO 130%	70 TO 130%	70 TO 130%	70 TO 130%
INNER SURFACE Ba-ENRICHED LAYER THICKNESS	6μm	6μm	6μm	6μm	7μm	5μm
OUTER SURFACE APPLICATION FILM Ba CONCENTRATION (atoms/cm ²)	8.0E15	8.0E15	8.0E15	8.0E15	8.0E15	3.0E16
OUTER SURFACE CRYSTAL ORIENTATION	DOME-SHAPED	DOME-SHAPED	DOME-SHAPED	DOME-SHAPED	DOME-SHAPED	DOME-SHAPED
OUTER CRYSTAL LAYER THICKNESS GRADIENT	0.8 TO 1.2	0.8 TO 1.2	0.8 TO 1.2	0.8 TO 1.2	0.8 TO 1.2	0.8 TO 1.2
OUTER SURFACE Ba CONCENTRATION GRADIENT	70 TO 130%	70 TO 130%	70 TO 130%	70 TO 130%	70 TO 130%	70 TO 130%
OUTER SURFACE Ba-ENRICHED LAYER THICKNESS	6μm	6μm	6μm	6μm	6μm	6μm
CRYSTAL LAYER THICKNESS RATIO (INNER SURFACE/ OUTER SURFACE)	4.5	0.6	1.5	1.2	2.5	0.6
APPLICATION FILM Ba CONCENTRATION RATIO (INNER SURFACE/ OUTER SURFACE)	12.5	1	12.5	1	30	0.2
GLASS VISCOSITY RATIO	INNER SIDE/ OUTER SIDE =0.8	INNER SIDE/ OUTER SIDE =2.0	INNER SIDE/ OUTER SIDE =6.5	INNER SIDE/ OUTER SIDE =0.1	INNER SIDE/ OUTER SIDE =2	INNER SIDE/ OUTER SIDE =0.8
CRUCIBLE DEFORMATION	NO DEFORMATION	NO DEFORMATION	NO DEFORMATION	NO DEFORMATION	NO DEFORMATION	NO DEFORMATION
PRESENCE OR ABSENCE OF WRINKLES AND CRACKS	NO WRINKLES	NO WRINKLES	NO WRINKLES	NO WRINKLES	NO WRINKLES	NO WRINKLES
DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION
SINGLE CRYSTALLINITY	89%	88%	86%	87%	85%	85%

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FIG. 21

SAMPLE	X7	X8	X9	X10	X11
CRYSTAL LAYER POSITION	INNER SURFACE + OUTER SURFACE	INNER SURFACE + OUTER SURFACE	INNER SURFACE + OUTER SURFACE	INNER SURFACE + OUTER SURFACE	INNER SURFACE + OUTER SURFACE
INNER SURFACE APPLICATION FILM Ba CONCENTRATION (atoms/cm ²)	1.0E17	1.0E17	2.4E17	2.4E17	8.0E15
INNER SURFACE CRYSTAL ORIENTATION	DOME-SHAPED + COLUMNAR	DOME-SHAPED + COLUMNAR	DOME-SHAPED + COLUMNAR	DOME-SHAPED + COLUMNAR	DOME-SHAPED
INNER CRYSTAL LAYER THICKNESS GRADIENT	PLACES HAVING 0.2 PRESENT	PLACES HAVING 0.2 PRESENT	PLACES HAVING 0.2 PRESENT	0.8 TO 1.2	0.8 TO 1.2
INNER SURFACE Ba CONCENTRATION GRADIENT	PLACES HAVING 30% PRESENT	PLACES HAVING 30% PRESENT	PLACES HAVING 30% PRESENT	70 TO 130%	70 TO 130%
INNER SURFACE Ba-ENRICHED LAYER THICKNESS	6um	6um	7um	7um	6um
OUTER SURFACE APPLICATION FILM Ba CONCENTRATION (atoms/cm ²)	8.0E15	8.0E15	8.0E15	8.0E15	1.0E17
OUTER SURFACE CRYSTAL ORIENTATION	DOME-SHAPED	DOME-SHAPED	DOME-SHAPED	DOME-SHAPED	DOME-SHAPED + COLUMNAR
OUTER CRYSTAL LAYER THICKNESS GRADIENT	PLACES HAVING 0.2 PRESENT	PLACES HAVING 0.2 PRESENT	PLACES HAVING 0.2 PRESENT	0.8 TO 1.2	0.8 TO 1.2
OUTER SURFACE Ba CONCENTRATION GRADIENT	PLACES HAVING 30% PRESENT	PLACES HAVING 30% PRESENT	PLACES HAVING 30% PRESENT	70 TO 130%	70 TO 130%
OUTER SURFACE Ba-ENRICHED LAYER THICKNESS	6um	6um	6um	6um	6um
CRYSTAL LAYER THICKNESS RATIO (INNER SURFACE/OUTER SURFACE)	4.5	1.5	4	6.5	0.1
APPLICATION FILM Ba CONCENTRATION RATIO (INNER SURFACE/OUTER SURFACE)	12.5	12.5	30	30	0.08
GLASS VISCOSITY RATIO	INNER SIDE/ OUTER SIDE =0.8	INNER SIDE/ OUTER SIDE =6.5	INNER SIDE/ OUTER SIDE =2	INNER SIDE/ OUTER SIDE =7.5	INNER SIDE/ OUTER SIDE =0.1
CRUCIBLE DEFORMATION	NO DEFORMATION	NO DEFORMATION	NO DEFORMATION	NO DEFORMATION	NO DEFORMATION
PRESENCE OR ABSENCE OF WRINKLES AND CRACKS	SOME WRINKLES PRESENT, NO CRACKS	SOME WRINKLES PRESENT, NO CRACKS	SOME WRINKLES PRESENT, NO CRACKS	SOME WRINKLES PRESENT ON INNER SIDE, NO CRACKS	SOME WRINKLES PRESENT ON OUTER SIDE, NO CRACKS
DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION
SINGLE CRYSTALLINITY	81%	79%	80%	80%	86%

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FIG. 22

SAMPLE	X12	X13	X14	X15	X16	X17	X18
CRYSTAL LAYER POSITION	ONLY INNER SURFACE	ONLY INNER SURFACE	ONLY INNER SURFACE	ONLY INNER SURFACE	ONLY INNER SURFACE	ONLY INNER SURFACE	ONLY INNER SURFACE
INNER SURFACE APPLICATION FILM Ba CONCENTRATION (atoms/cm ²)	1.0E17	1.0E17	1.0E17	1.0E17	1.0E17	4.0E17	8.0E17
INNER SURFACE CRYSTAL ORIENTATION	DOME-SHAPED + COLUMNAR	DOME-SHAPED + COLUMNAR	DOME-SHAPED + COLUMNAR	DOME-SHAPED + COLUMNAR	DOME-SHAPED + COLUMNAR	DOME-SHAPED + COLUMNAR	DOME-SHAPED + COLUMNAR
INNER SURFACE CRYSTAL LAYER THICKNESS GRADIENT	0.8 TO 1.2	0.8 TO 1.2	0.8 TO 1.2	0.8 TO 1.2	PLACES HAVING 0.2 PRESENT	0.8 TO 1.2	0.8 TO 1.2
INNER SURFACE Ba CONCENTRATION GRADIENT	70 TO 130%	70 TO 130%	70 TO 130%	70 TO 130%	PLACES HAVING 30% PRESENT	70 TO 130%	70 TO 130%
INNER SURFACE Ba-ENRICHED LAYER THICKNESS	0.6um	18um	6um	6um	6um	30um	80um
OUTER SURFACE APPLICATION FILM Ba CONCENTRATION (atoms/cm ²)							
OUTER SURFACE CRYSTAL ORIENTATION							
OUTER SURFACE CRYSTAL LAYER THICKNESS GRADIENT							
OUTER SURFACE Ba CONCENTRATION GRADIENT							
OUTER SURFACE Ba-ENRICHED LAYER THICKNESS							
GLASS VISCOSITY RATIO	OUTER SIDE/ INNER SIDE =3.0	OUTER SIDE/ INNER SIDE =3.0	OUTER SIDE/ INNER SIDE =0.3	OUTER SIDE/ INNER SIDE =12	OUTER SIDE/ INNER SIDE =3.0	OUTER SIDE/ INNER SIDE =3.0	OUTER SIDE/ INNER SIDE =3.0
CRUCIBLE DEFORMATION	NO DEFORMATION	NO DEFORMATION	SLIGHT DEFORMATION	SLIGHT DEFORMATION	NO DEFORMATION	NO DEFORMATION	NO DEFORMATION
PRESENCE OR ABSENCE OF WRINKLES AND CRACKS	NO WRINKLES	NO WRINKLES	NO WRINKLES	NO WRINKLES	SOME WRINKLES PRESENT, NO CRACKS	SOME WRINKLES PRESENT, NO CRACKS	WRINKLES PRESENT, CRACKS PRESENT
DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION
SINGLE CRYSTALLINITY	89%	93%	81%	81%	80%	83%	72%

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FIG. 23

SAMPLE	X19	X20	X21	X22	X23	X24
CRYSTAL LAYER POSITION	ONLY OUTER SURFACE	ONLY OUTER SURFACE	ONLY OUTER SURFACE	ONLY OUTER SURFACE	ONLY OUTER SURFACE	ONLY OUTER SURFACE
INNER SURFACE APPLICATION FILM Ba CONCENTRATION (atoms/cm ²)						
INNER SURFACE CRYSTAL ORIENTATION						
INNER CRYSTAL LAYER THICKNESS GRADIENT						
INNER SURFACE Ba CONCENTRATION GRADIENT						
INNER SURFACE Ba-ENRICHED LAYER THICKNESS						
OUTER SURFACE APPLICATION FILM Ba CONCENTRATION (atoms/cm ²)	8.0E15	8.0E15	8.0E15	8.0E15	4.0E17	8.0E17
OUTER SURFACE CRYSTAL ORIENTATION	DOME-SHAPED	DOME-SHAPED	DOME-SHAPED	DOME-SHAPED	DOME-SHAPED + COLUMNAR	DOME-SHAPED + COLUMNAR
OUTER SURFACE CRYSTAL LAYER THICKNESS GRADIENT	0.8 TO 1.2	0.8 TO 1.2	0.8 TO 1.2	PLACES HAVING 0.2 PRESENT	0.8 TO 1.2	0.8 TO 1.2
OUTER SURFACE Ba CONCENTRATION GRADIENT	70 TO 130%	70 TO 130%	70 TO 130%	PLACES HAVING 30% PRESENT	70 TO 130%	70 TO 130%
OUTER SURFACE Ba-ENRICHED LAYER THICKNESS	0.6um	18um	6um	6um	50um	80um
GLASS VISCOSITY RATIO	INNER SIDE/ OUTER SIDE =2.0	INNER SIDE/ OUTER SIDE =2.0	INNER SIDE/ OUTER SIDE =0.3	INNER SIDE/ OUTER SIDE =2.0	INNER SIDE/ OUTER SIDE =2.0	OUTER SIDE/ INNER SIDE =3.0
CRUCIBLE DEFORMATION	NO DEFORMATION	NO DEFORMATION	SLIGHT DEFORMATION	NO DEFORMATION	NO DEFORMATION	SLIGHT DEFORMATION
PRESENCE OR ABSENCE OF WRINKLES AND CRACKS	NO WRINKLES	NO WRINKLES	NO WRINKLES	SOME WRINKLES PRESENT, NO CRACKS	SOME WRINKLES PRESENT, NO CRACKS	WRINKLES PRESENT, CRACKS PRESENT
DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION	NO DELAMINATION
SINGLE CRYSTALLINITY	88%	93%	80%	79%	88%	72%

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FIG. 24

SAMPLE	Y1	Y2	Y3	Y4	Y5	Y6
CRYSTAL LAYER POSITION	INNER SURFACE + OUTER SURFACE	INNER SURFACE + OUTER SURFACE	ONLY INNER SURFACE	ONLY INNER SURFACE	ONLY OUTER SURFACE	ONLY OUTER SURFACE
INNER SURFACE APPLICATION FILM Ba CONCENTRATION (atoms/cm ²)	3.0E15	1.0E14	1.0E14	1.0E14		
INNER SURFACE CRYSTAL ORIENTATION	RANDOM	RANDOM	RANDOM	RANDOM		
INNER CRYSTAL LAYER THICKNESS GRADIENT	PLACES HAVING 0.2 PRESENT	PLACES HAVING 0.2 PRESENT	0.5 TO 1.5	PLACES HAVING 0.2 PRESENT		
INNER SURFACE Ba CONCENTRATION GRADIENT	PLACES HAVING 30% PRESENT	PLACES HAVING 30% PRESENT	40 TO 150%	PLACES HAVING 30% PRESENT		
INNER SURFACE Ba-ENRICHED LAYER THICKNESS	DETECTION LIMIT OR LOWER	DETECTION LIMIT OR LOWER	DETECTION LIMIT OR LOWER	DETECTION LIMIT OR LOWER		
OUTER SURFACE APPLICATION FILM Ba CONCENTRATION (atoms/cm ²)	1.0E14	1.0E15			1.0E14	1.0E14
OUTER SURFACE CRYSTAL ORIENTATION	RANDOM	RANDOM			RANDOM	RANDOM
OUTER CRYSTAL LAYER THICKNESS GRADIENT	PLACES HAVING 0.2 PRESENT	PLACES HAVING 0.2 PRESENT			0.8 TO 1.2	PLACES HAVING 0.2 PRESENT
OUTER SURFACE Ba CONCENTRATION GRADIENT	PLACES HAVING 30% PRESENT	PLACES HAVING 30% PRESENT			70 TO 130%	PLACES HAVING 30% PRESENT
OUTER SURFACE Ba-ENRICHED LAYER THICKNESS	DETECTION LIMIT OR LOWER	DETECTION LIMIT OR LOWER			DETECTION LIMIT OR LOWER	DETECTION LIMIT OR LOWER
CRYSTAL LAYER THICKNESS RATIO (INNER SURFACE/ OUTER SURFACE)	6.5	0.1				
APPLICATION FILM Ba CONCENTRATION RATIO (INNER SURFACE/ OUTER SURFACE)	30	0.1				
GLASS VISCOSITY RATIO	INNER SIDE/ OUTER SIDE =30	INNER SIDE/ OUTER SIDE =0.1	OUTER SIDE/ INNER SIDE =3.0	OUTER SIDE/ INNER SIDE =12	OUTER SIDE/ INNER SIDE =3.0	INNER SIDE/ OUTER SIDE =0.3
CRUCIBLE DEFORMATION	DEFORMED	DEFORMED	DEFORMED	DEFORMED	DEFORMED	DEFORMED
PRESENCE OR ABSENCE OF WRINKLES AND CRACKS	WRINKLES PRESENT, CRACKS PRESENT	WRINKLES PRESENT, CRACKS PRESENT	NO WRINKLES	WRINKLES PRESENT, CRACKS PRESENT	NO WRINKLES	WRINKLES PRESENT, CRACKS PRESENT
DELAMINATION	DELAMINATION OCCURRED	DELAMINATION OCCURRED	NO DELAMINATION	DELAMINATION OCCURRED	NO DELAMINATION	DELAMINATION OCCURRED
SINGLE CRYSTALLINITY	53%	53%	59%	48%	60%	49%