RECENT STUDIES ON ACCERELATING STRUCTURE FABRICATION
(Evaluation of diffusion-bonded junction of DDS3D2.)

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Evaluation of diffusion-bonded junction of DDS3D2.

(1)Measurement principles and results.

① Liquid penetrant testing.

② Fluorescent penetrant testing.

③ Immersion ultrasonic testing.

④ Micro-observation.

(2)Calculation of shrinkage of void based on the theoretical formula by Kuczynski.

(3)Conclusion

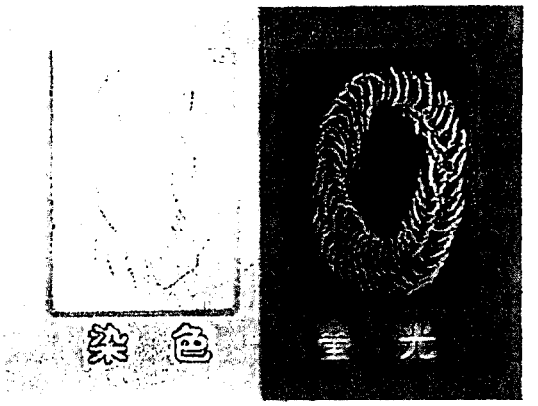


fig1

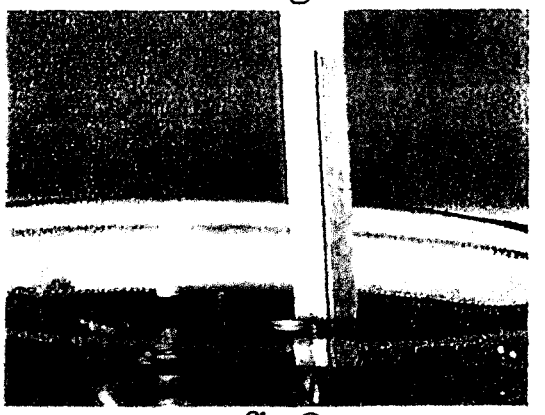


fig2

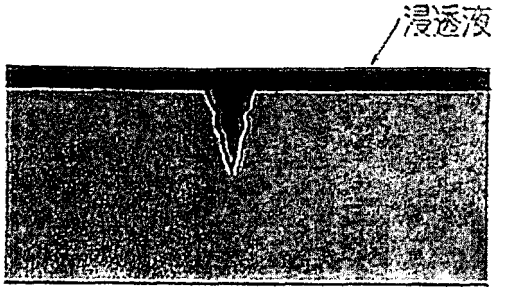


fig3

First apply
the penetrant liquid.
You can coat either
byabrushoraspray

Liquid penetrant testing

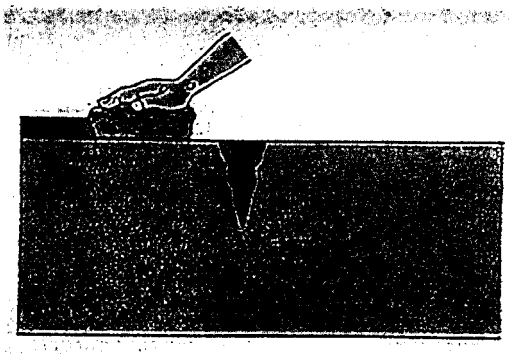
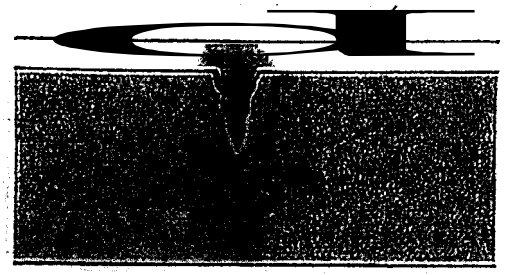


fig4

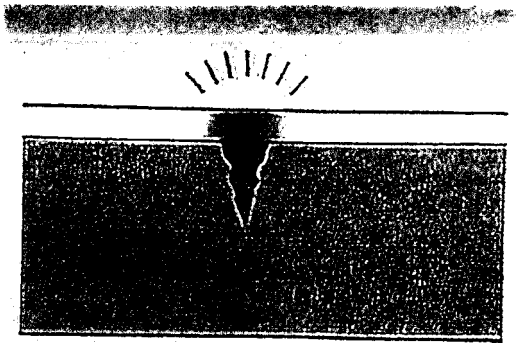
Wait for a moment
until the liquid
permeates the coat.
Next wipe
the surface clean.

the developing solution



Then spread
the developing solution

fig5



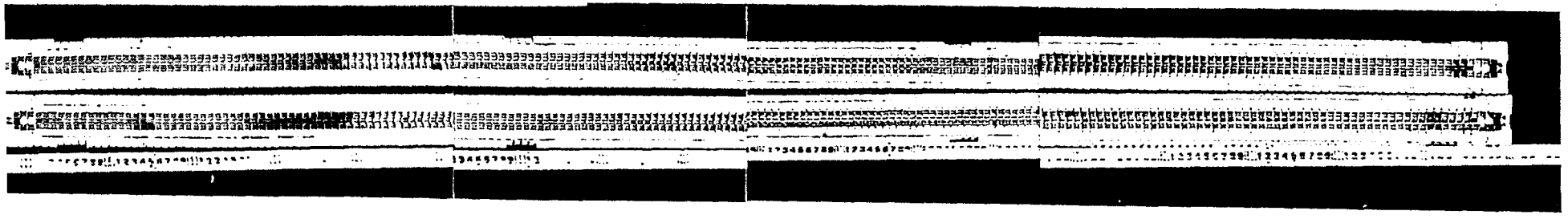
The permeating liquid ,
which is standing
the coat, comes out
to the surface through
the developing solution
by the capillary action .

fig6

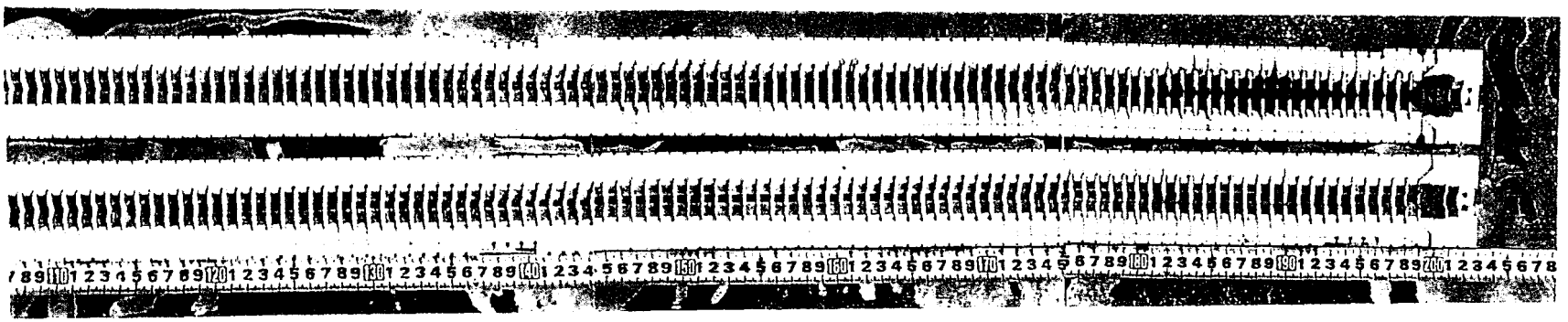
Before the test,
the surface must
be made clean.

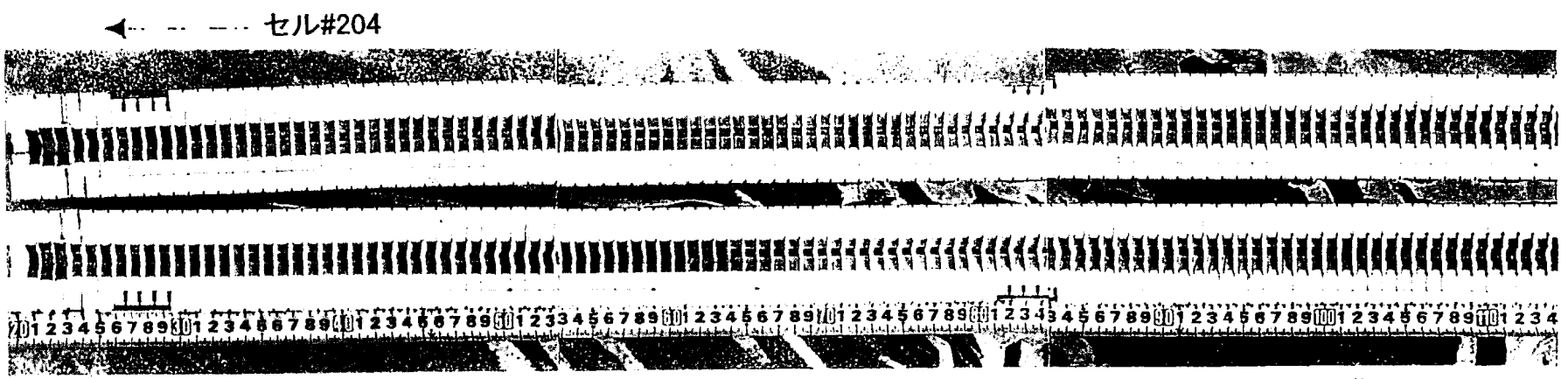
Fig7

cell#204 ←——— cell#001



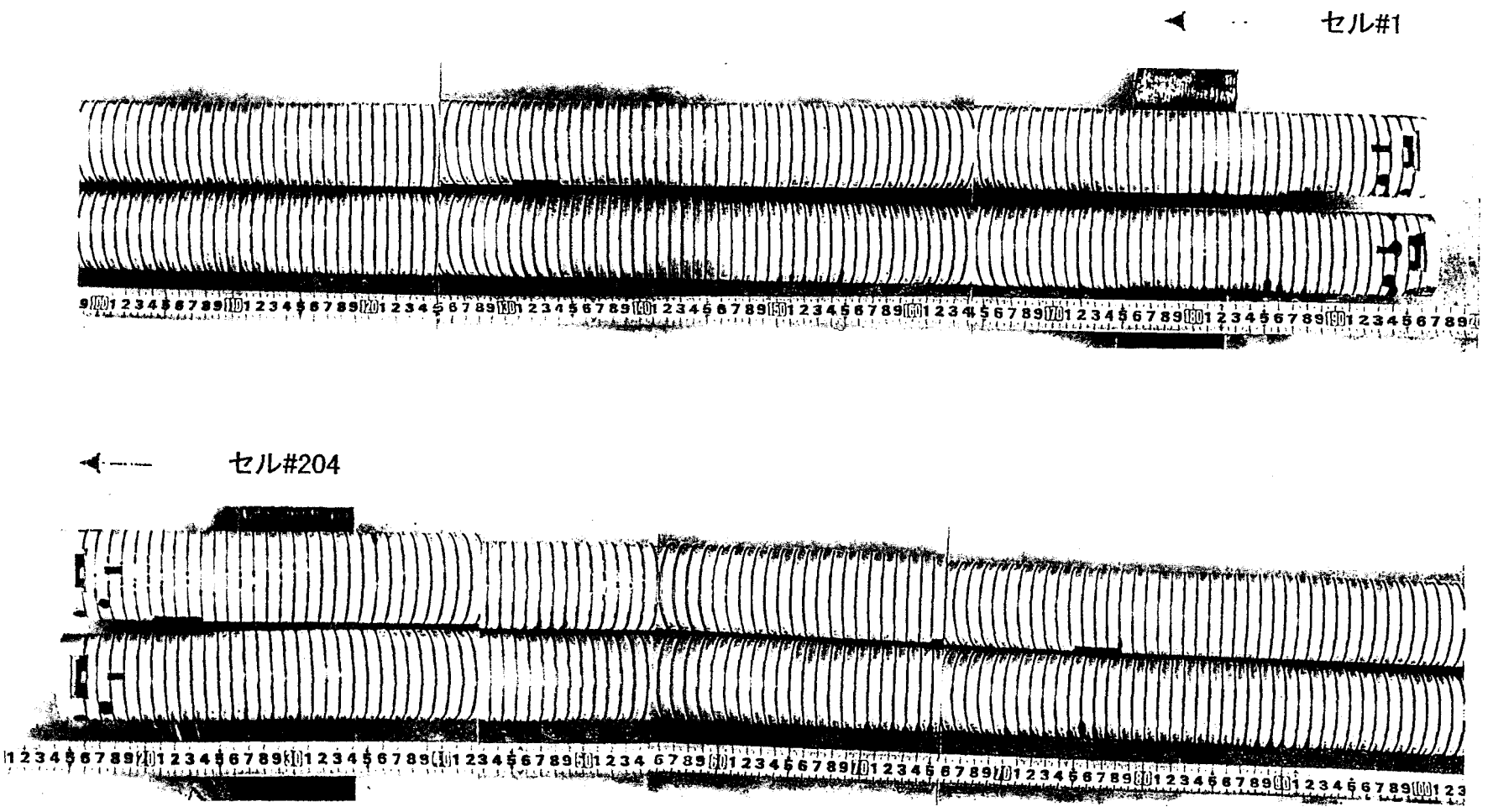
The appearance of the cutting face of DDS3D2





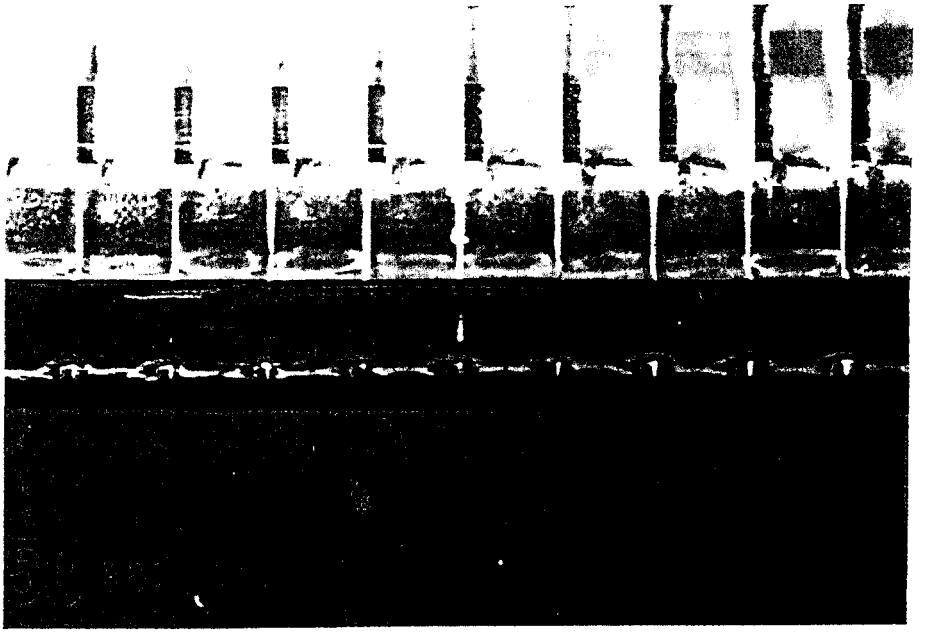
全セルで欠陥指示無し

Result of Liquid Penetrant Testing (cutting face of DDS3D2)

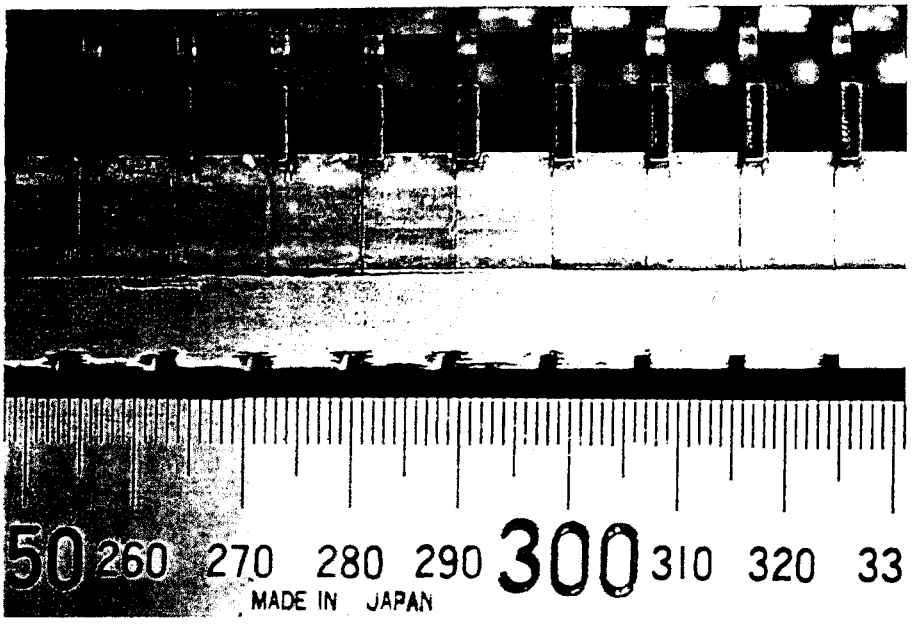


全セルで欠陥指示無し

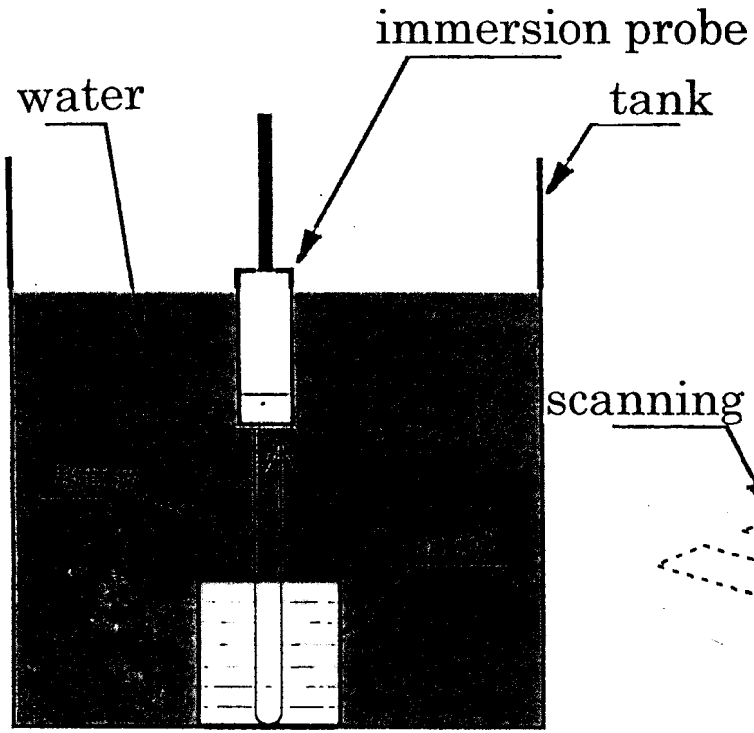
Result of Liquid Penetrant Testing (outside of the structure)



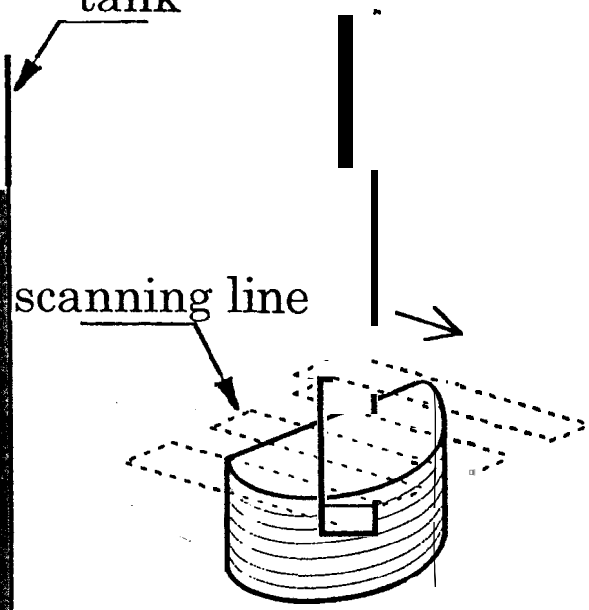
#138, #139間に指示



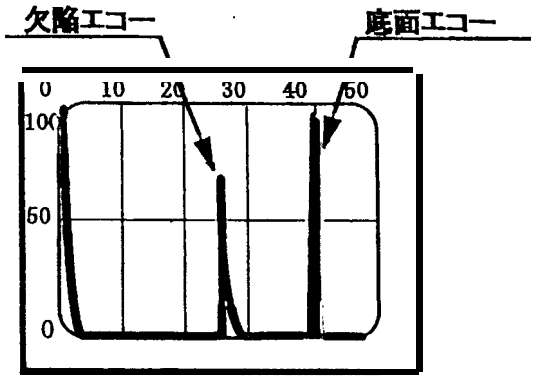
Result of fluorescent penetrant testing
(There was only one defect observed
between #138cell and #139cell)



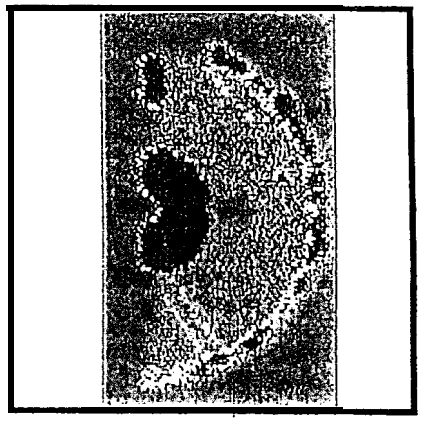
(1) 探傷風景



(2) 探触子走査



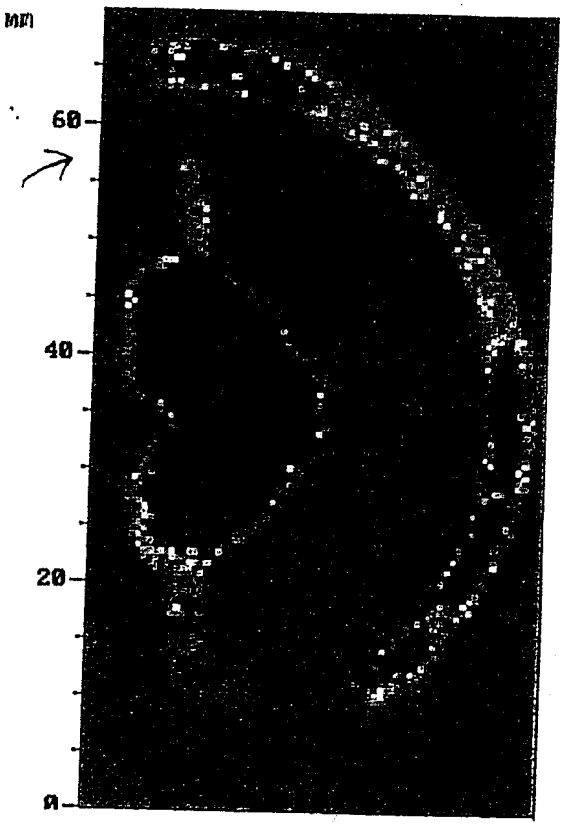
(3) 超音波波形



scan-image

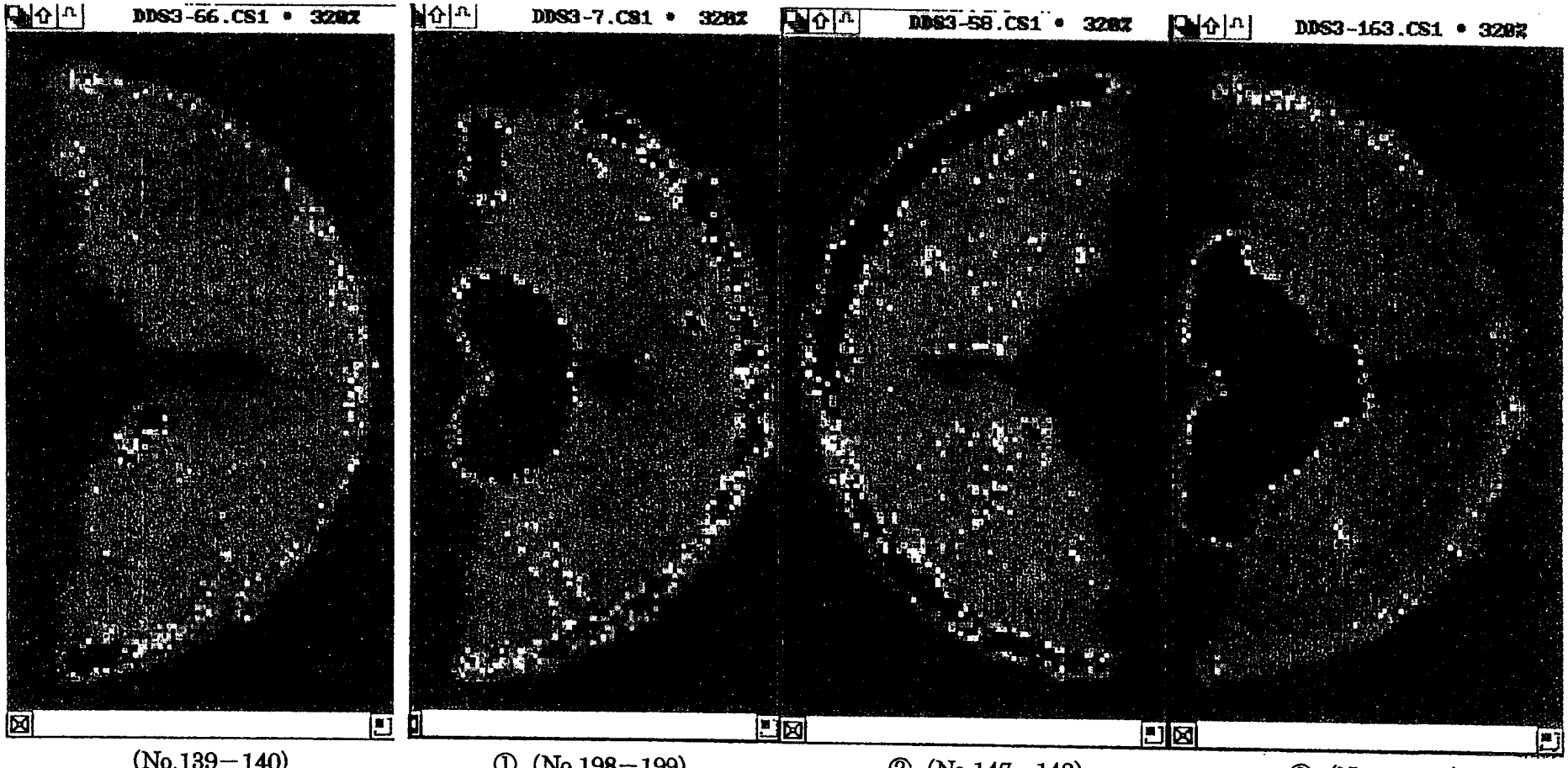
Immersion ultrasonic testing

矢印部がザイクロでの欠陥指示位置



(No.138－139)

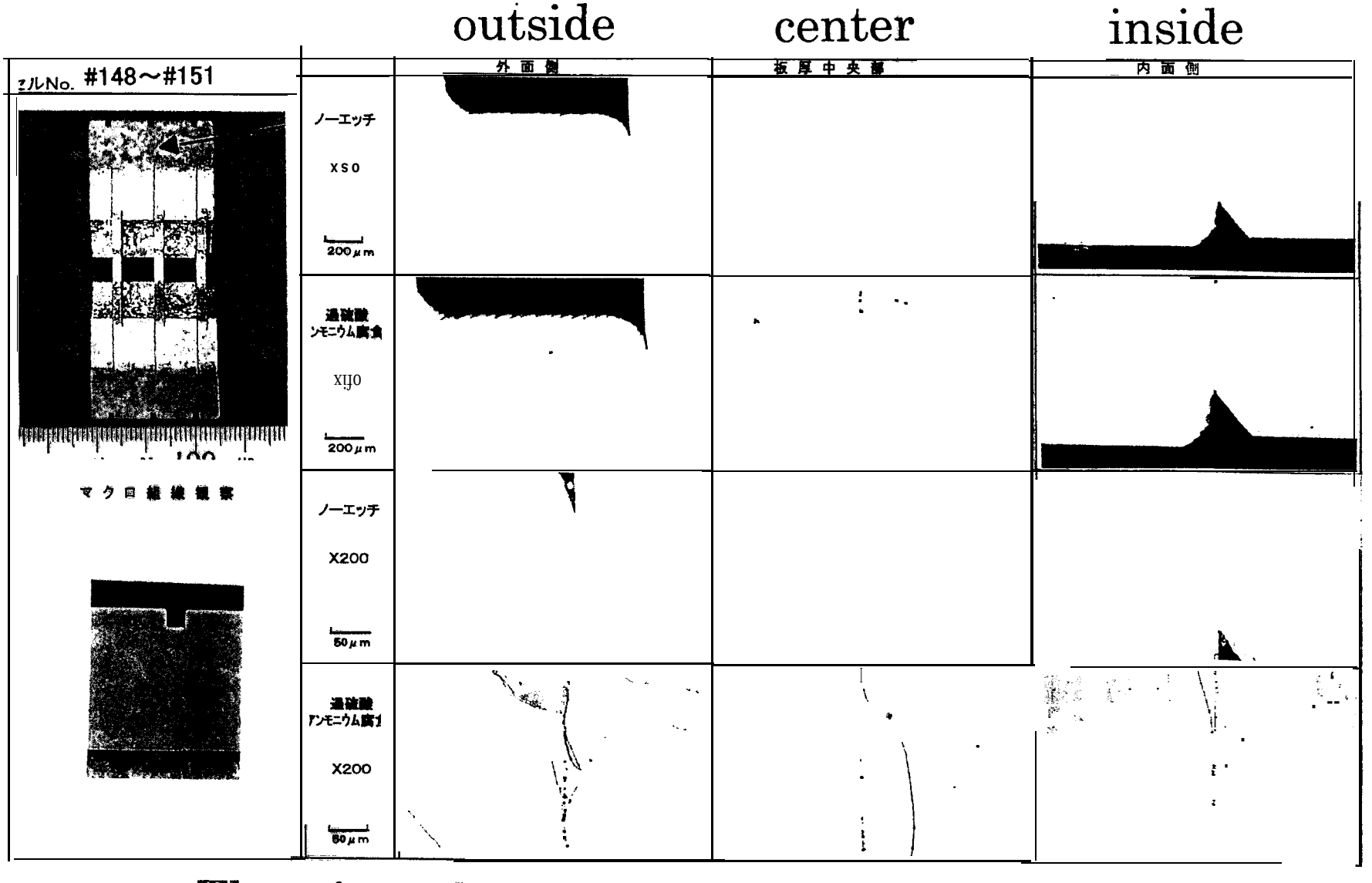
Result of immersion ultrasonic testing
(Where defect was detected
in fluorescent penetrant testing)



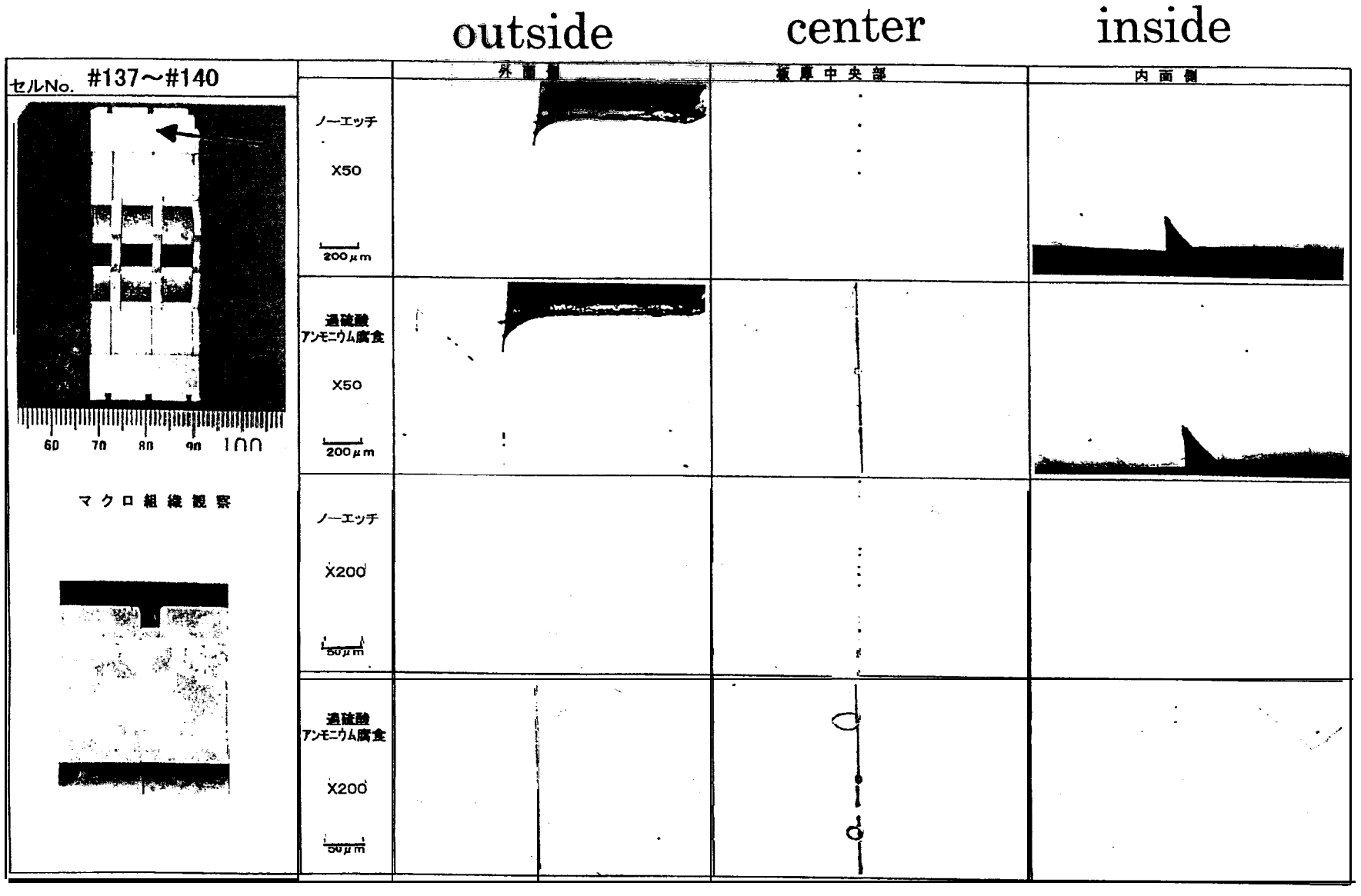
(No.139−140) ① (No.198−199) ② (No.147−148) ③ (No.41−42)

normal image defect candidate(① 2③)

Typical patterns obtained by immersion ultrasonic testing



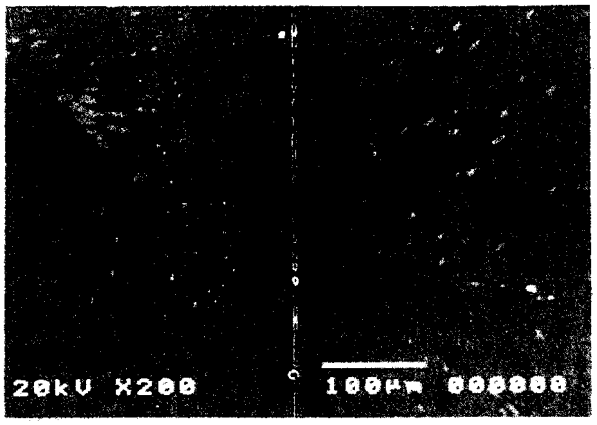
The micro-observation of well-bonded junction (#149 & #150)

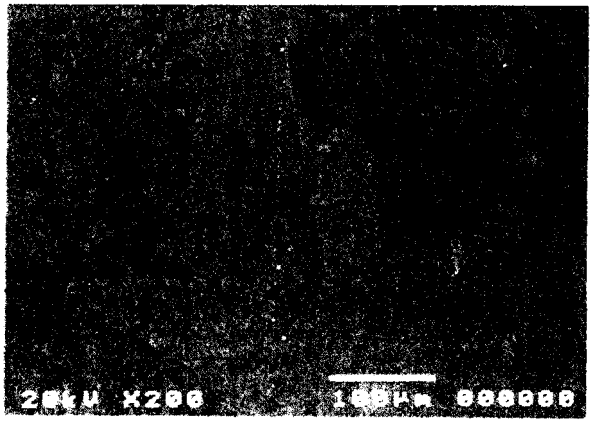


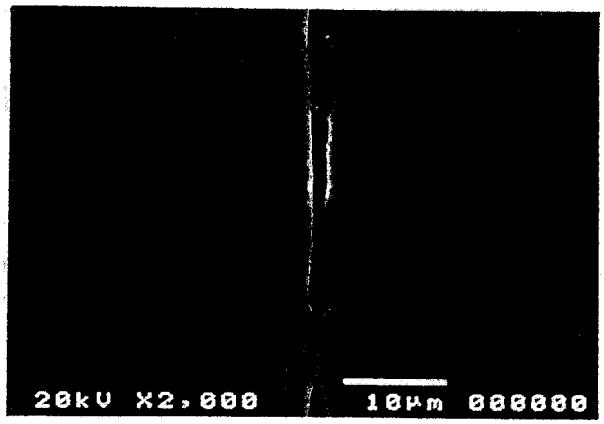
The micro-observation of defective part
(#138 & #139)

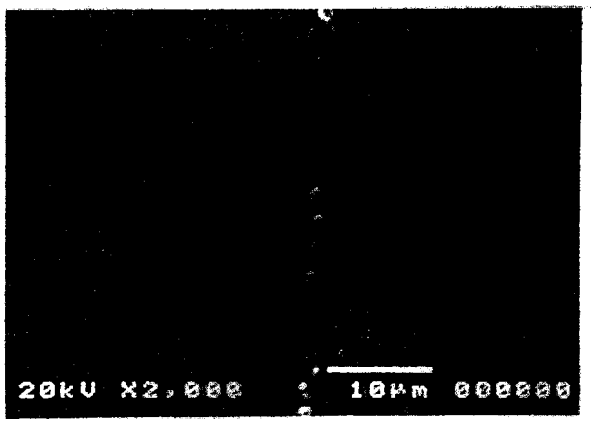
connecting part
between #138 and #139
(fluorescent penetrant testing
:there is defect)

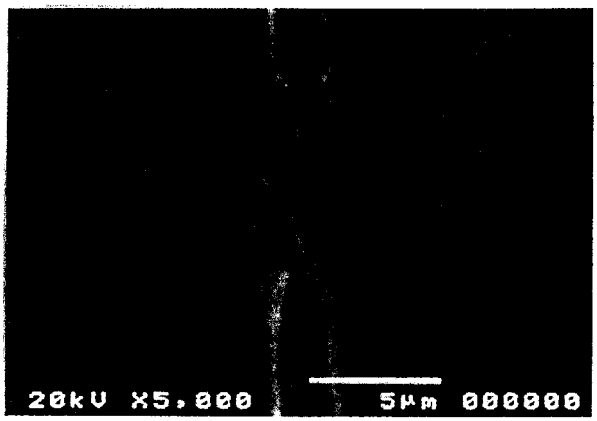
connecting part
between #149 and #150
(fluorescent penetrant testing
:there is not defect)

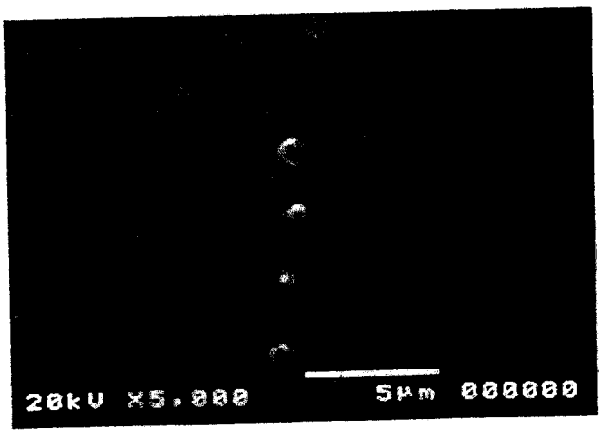












Result of SEM

Calculating results based on the theoretical formula by Kuczynski [1].

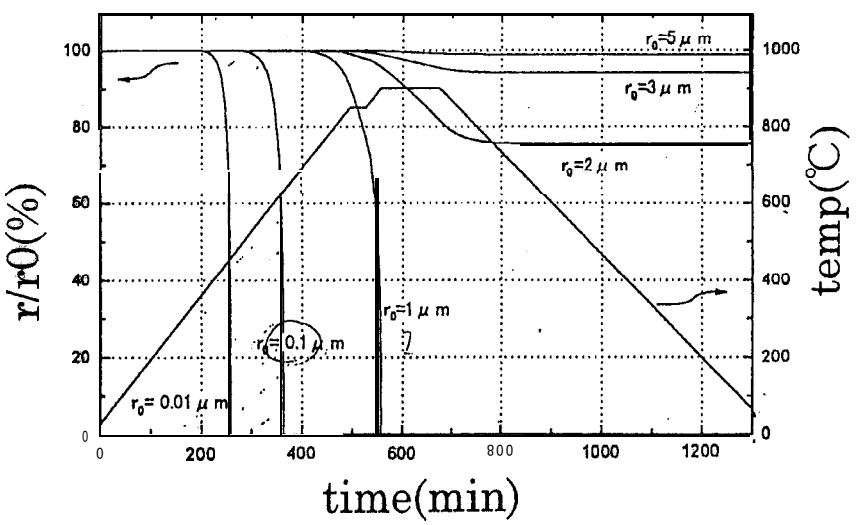
basic formula

$$r^3 = r_0^3 - \frac{6\gamma\delta^3 D}{kT} t$$

$$D = D_0 \exp\left(-\frac{Q}{RT}\right)$$

r0:initial radius of spherical cavity
r:radius of spherical cavity
k:Boltzmann factor
T:temperature
γ :surface tension
δ :interatomic distance
D:diffusion coefficient
D0:frequency factor
Q:activation energy
R:gas constant

$\gamma = 1.72$ (J/m²) [2]
$\delta = 2.56 \times 10^{-10}$ (m) [2]
$D_0 = 6.20 \times 10^{-5}$ (m²/sec) [2]
$Q = 2.08 \times 10^{5}$ (J/mol) [2]



The relationship between the b o ding time and the ratio of r/r0(× 1 00 %) duaring the heat treatment

a reference book

[1]G.C.Kuczynski: The Mechanism o f Densification during Sintering of Metallic Particles, Acta Met.,vol.4(1956), 58-61

3.Conclusion

(1)Defects were observed in

1 junction out of 200(Fluorescent penetrant testing)

3 junction out of 30(Immersion ultrasonic testing)

(2)In order to make the bonding reliable, we should study the cleanness in the fabrication area, improve the quality of cells, or something obxs