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Qualification Test Report on NE292series

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This report presents the qualification test results on NE292series .
NE292series are Hetero Junction FET die that utilizes hetero junction between Si-doped AlGaAs and undoped InGaAs to create high mobility electrons .

1. *Test Device*
   NE29283B (83B : hermetic seal ceramic package)

2. *Qualification test*
   A series of qualification tests consists of following items :
   1) High Temperature DC Bias Test
   2) High Temperature Reverse Bias Test
   3) High Temperature Storage Test
   The test conditions are shown in Table 1 . The test parameters and criteria are shown in Table 2 .

3. *Test Results*
   1) High Temperature DC Bias Test (HTPT)
   No failure has been observed in HTPT until 5000 hours . The test results are shown in Table 3 and the change of all parameters are shown in Figure 1 .

   2) High Temperature Reverse Bias Test (HTBT)
   No failure has been observed in HTBT until 5000 hours . The test results are shown in Table 3 and the change of all parameters are shown in Figure 2 .

   3) High Temperature Storage Test (HT)
   In order to investigate metallurgical stability such as gate , drain and source electrodes , HT-test were performed at Ta=227℃, 259℃, 295℃ and 337℃ .
   The test results are shown in Table 4 and the change of all parameters are shown in Figure 3 ~ 6 . The failure mode has been confirmed to be VGF degradation .
   The decrease of VGF is considered to be due to gate schottky degradation caused by some metallurgical reaction between Ti of gate metal (Ti-Al) and AlGaAs in gate recess.
   The Weibull plots and the Arrhenius plots are shown in Figure 7 and 8 respectively .
   They were plotted according to the results under the failure mode of △VGF = -20% .
   The MTTF value at the channel temperature of 125℃ was estimated to be 4.0×10^8 hours under the failure mode of △VGF = -20% (activation energy of 1.86eV) .

4. *Conclusion*
   From above-mentioned HT-test result , the MTTF value of NE29283B is estimated to be 4.0×10^8 hours at the channel temperature of 125℃ .
   Moreover , no failure has been observed in HTPT and HTBT until 5000 hours .
   Therefore , the NE292series demonstrates high reliability performance for the operating at channel temperature of 125℃ and below .

Table 1. Qualification test item and test condition

Test Item	*Test Condition*	*Quantity*	*Remarks*
High Temperature DC Bias Test	*Tch=175℃, Vds=3V, Ids=15mA* *t=5000hr, up to F(t)>50%*	*20pcs*	*No degradation* *up to 5000hr*
High Temperature Reverse Bias Test	*Ta=150℃, Vgss=-2.4V* *t=5000hr, up to F(t)>50%*	*20pcs*	*No degradation* *up to 5000hr*
High Temperature Storage Test	*Ta=227℃, 259℃, 295℃, 337℃*	*each 10pcs*	*No degradation* *up to 5000hr*

Table 2. Electrical parameter and Criteria

Electrical Parameter	*Symbol*	*Test Condition*	*Delta Criteria*
Gate to Source Forward Voltage	*VF(GS)*	*VGS= 1uA*	*±20%*
Gate to Source Leak Current	*IGSO*	*VGS= -3V*	*+300nA or +100% whichever is greater*
Drain Current	*IDS*	*VDS= 0.5V, VGS= 0V*	*±20%*
Saturated Drain Current	*IDSS*	*VDS= 2.0V, VGS= 0V*	*±20%*
Transconductance	*gm*	*VDS= 2.0V, IDS= 10mA*	*±20%*
Gate to Source Cutoff Voltage	*Vp*	*VDS= 2.0V, IDS= 100uA*	*±20%*

Table 3. Summary of Qualification Test Results on NE29283B

Test Item	Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)						Ref. Figure
		168	500	1088	2094	3259	5011	
High Temperature DC Bias Test	Tch=175℃ Vds=3.0V, Ids=15mA	0/20	0/20	0/20	0/20	0/20	0/20	Figure 1

Test Item	Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)						Ref. Figure
		236	473	1426	2091	3047	5048	
High Temperature Reverse Bias Test	Ta=150℃ Vgss=-2.4V	0/20	0/20	0/20	0/20	0/20	0/20	Figure 2

Table 4. Summary of High Temperature Storage Test Results on NE29283B

Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)									Ref. Figure
	24	168	495	1072	1525	2000	3122	4122	5075	
Ta=227℃	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	0/10	Figure 3

Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)									Ref. Figure
	24	48	96	168	352	495	740	1072	1525	
Ta=259℃	0/10	0/10	0/10	0/10	0/10	6/10	10/10	10/10	10/10	Figure 4

Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)					Ref. Figure
	6	12	24	48	96	
Ta=295℃	0/10	0/10	0/10	0/10	0/10	Figure 5

Test Condition	Cumulative Failure number with Elapsed Time [H] (Failure / Sample)									Ref. Figure
	0.5	1	2	4	8	16	32	64	96	
Ta=337℃	0/10	0/10	0/10	10/10	10/10	10/10	10/10	10/10	10/10	Figure 6

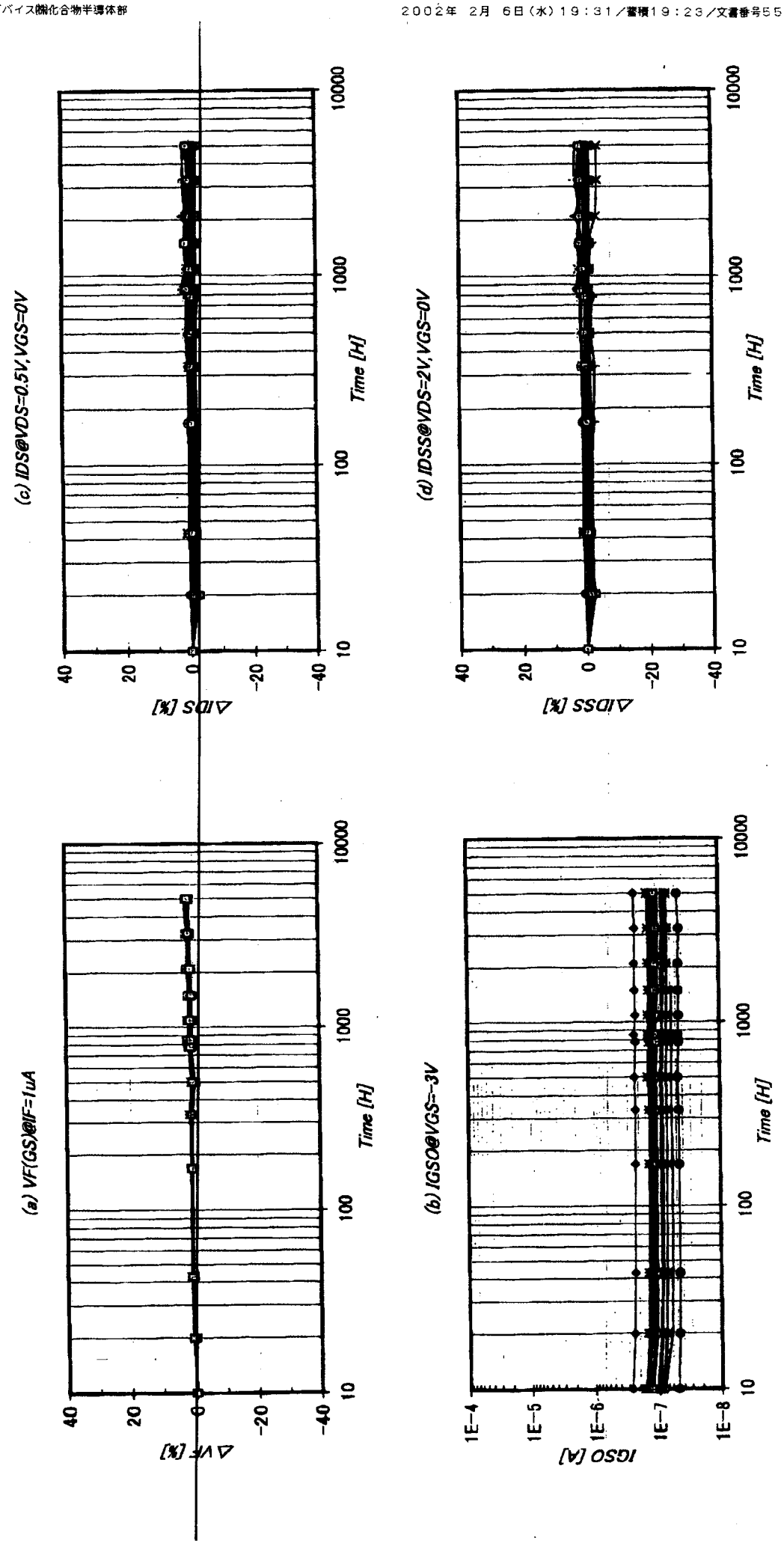
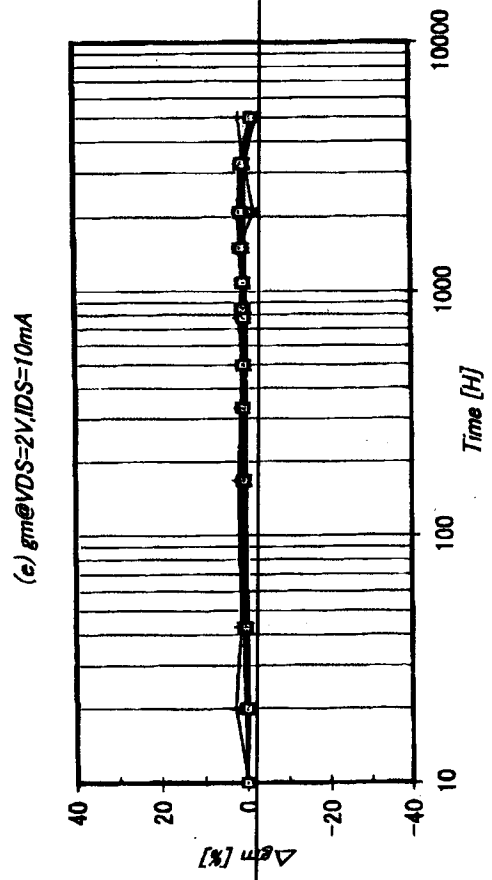


Figure 1-1. High Temperature DC Bias Test Results (Tch=175℃,Vds=3V,Ids=15mA)



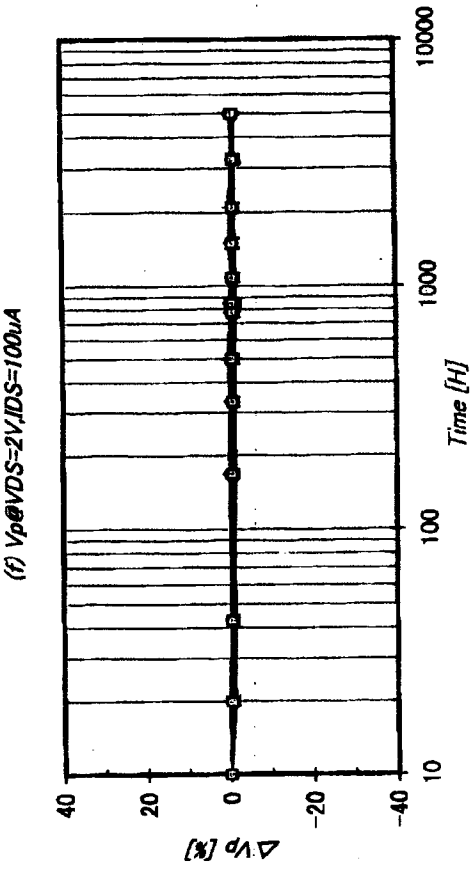


Figure 1-2. High Temperature DC Bias Test Results (Tch=175℃,Vds=3V,Ids=15mA)

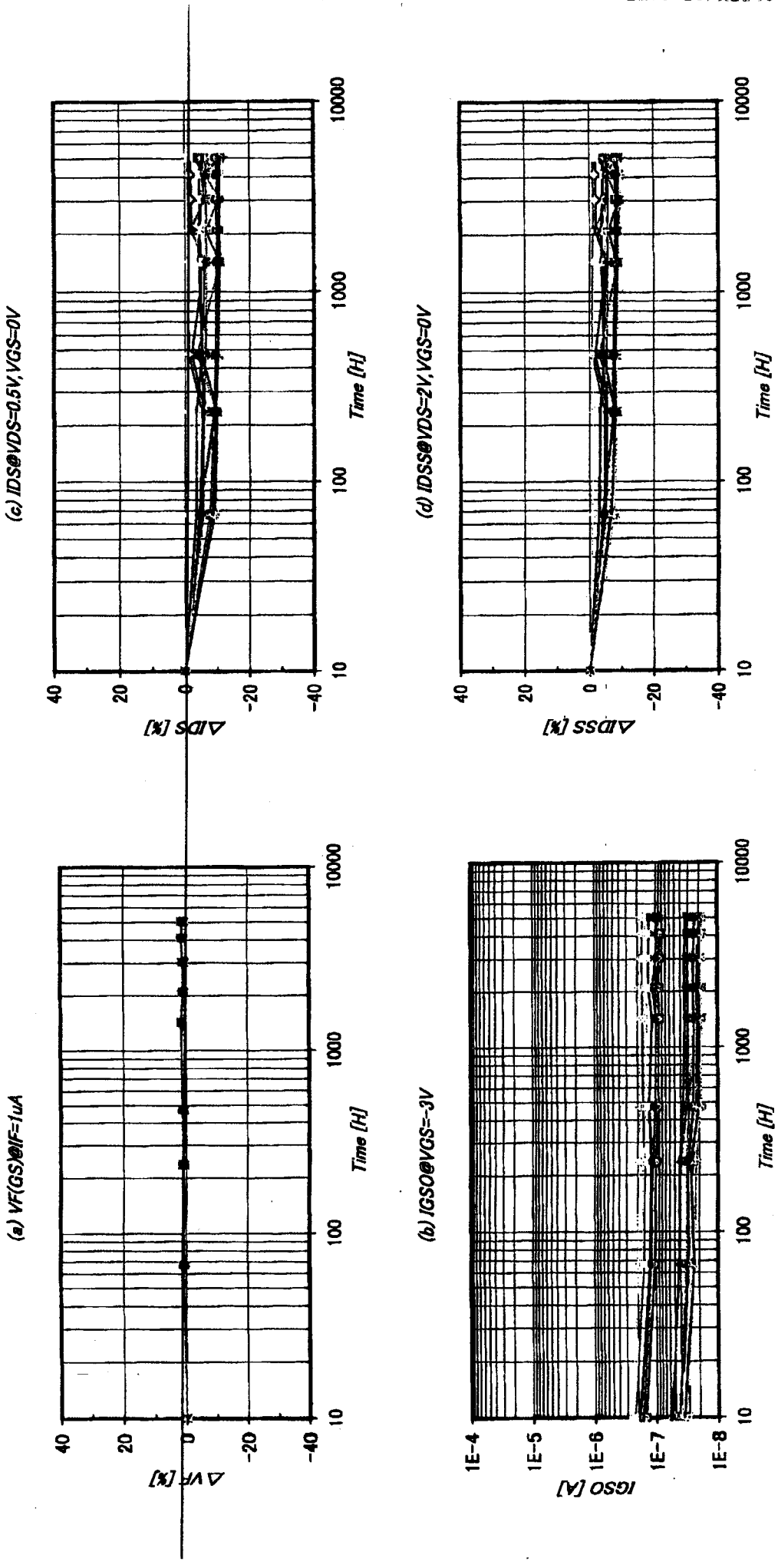
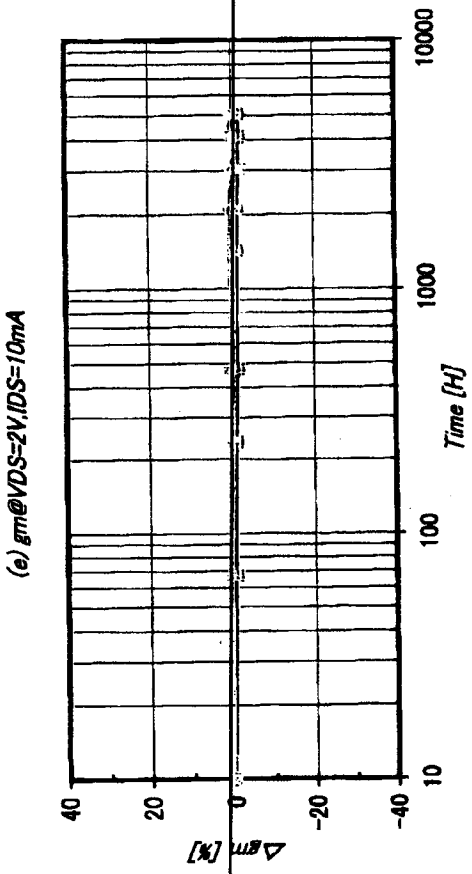


Figure 2-1. High Temperature Reverse Bias Test Results (Ta=150℃,Vgss=-2.4V)



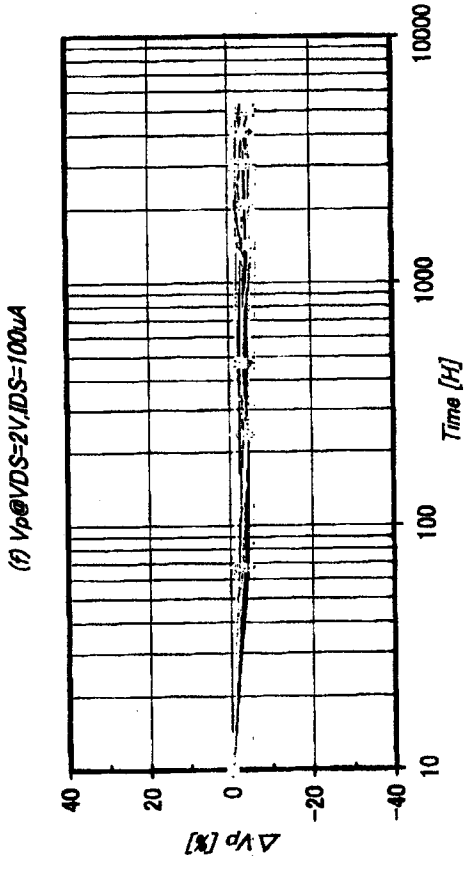


Figure 2-2. High Temperature Reverse Bias Test Results (Ta=150℃,Vgss=-2.4V)

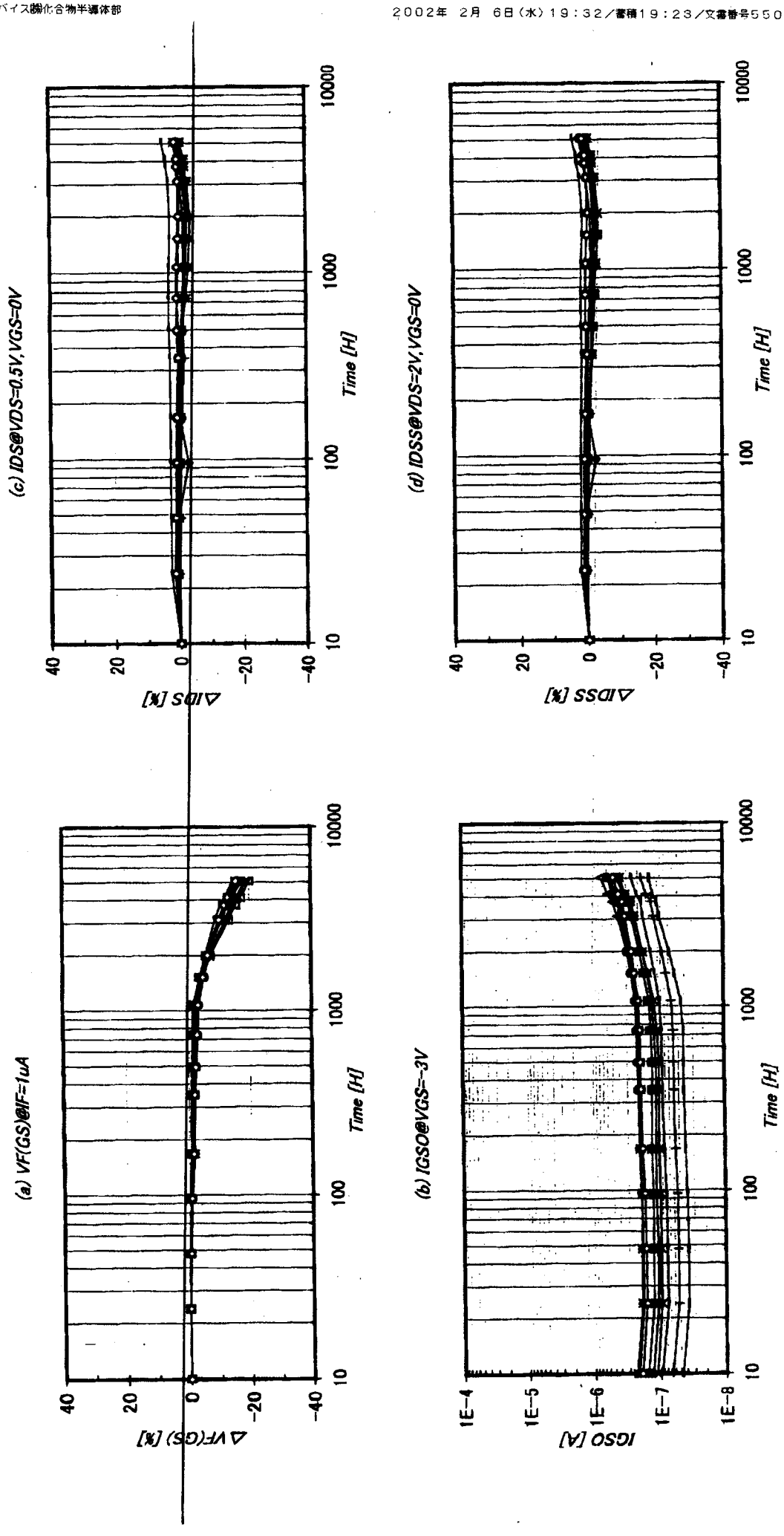
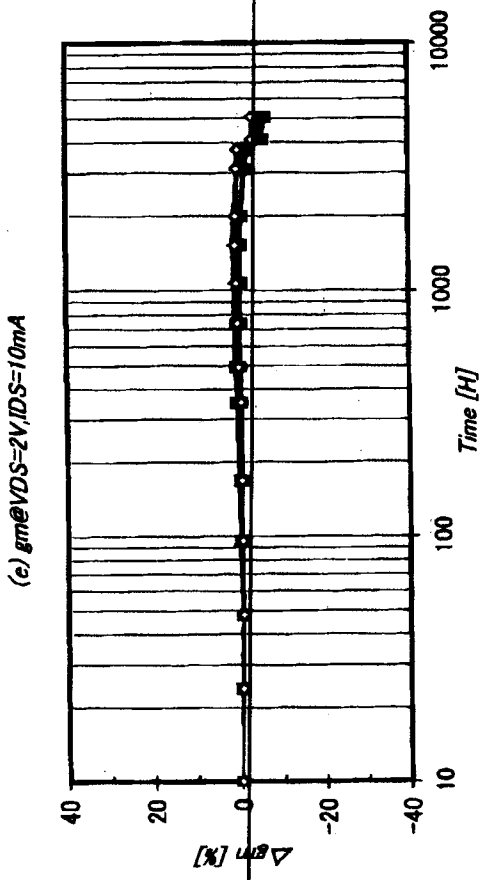


Figure 3-1. High Temperature Storage Test Results (Ta=227℃)



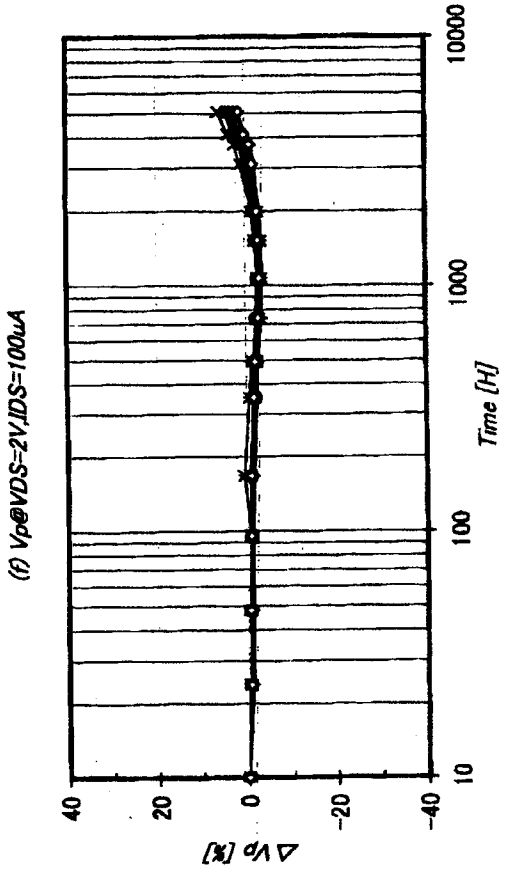


Figure 3-2. High Temperature Storage Test Results (Ta=227°C)

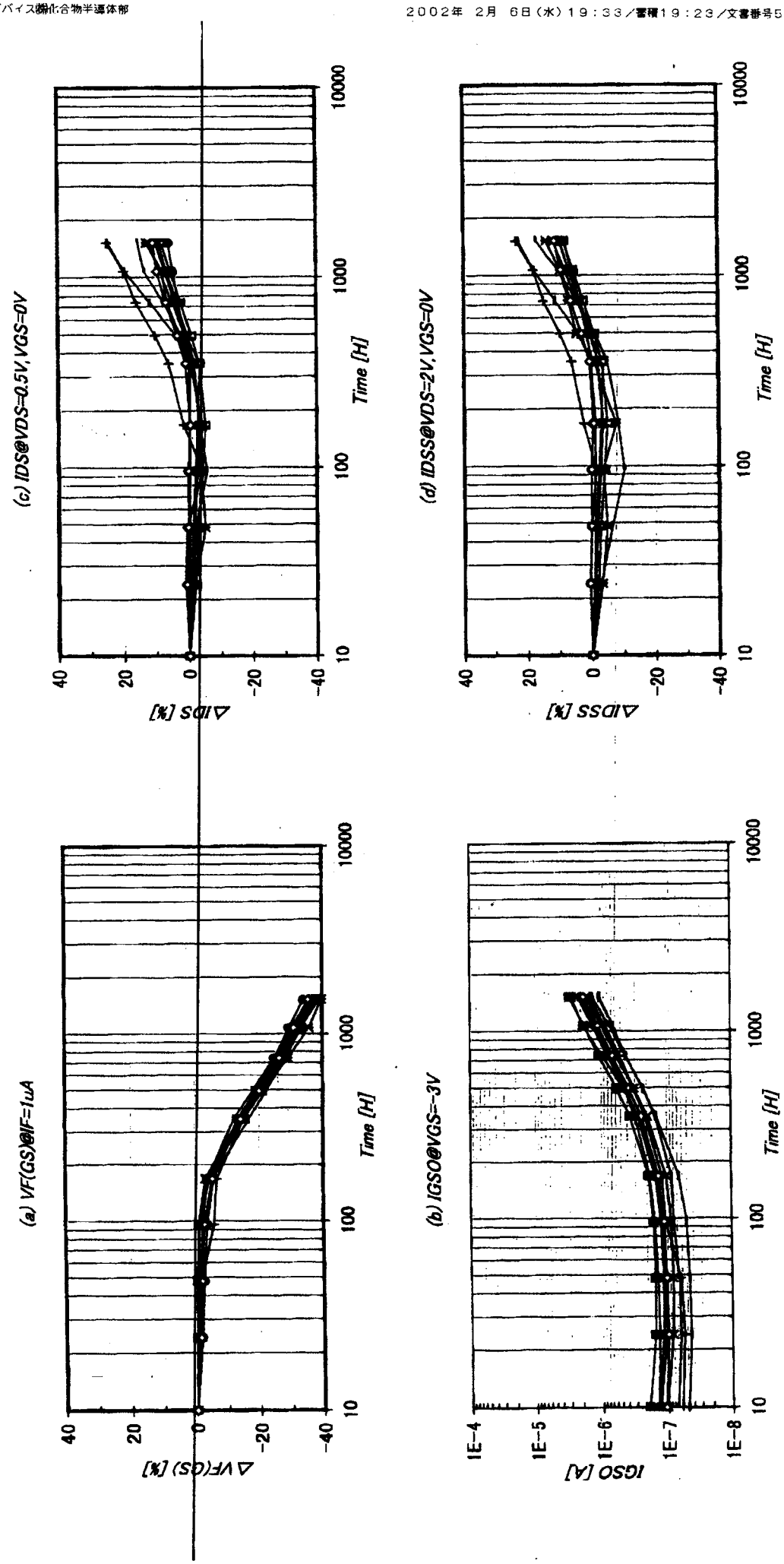
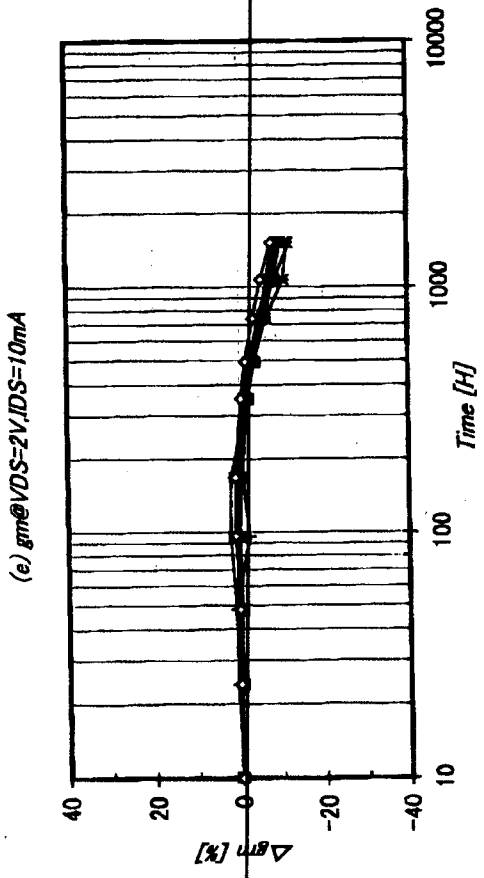


Figure 4-1. High Temperature Storage Test Results (Ta=259℃)



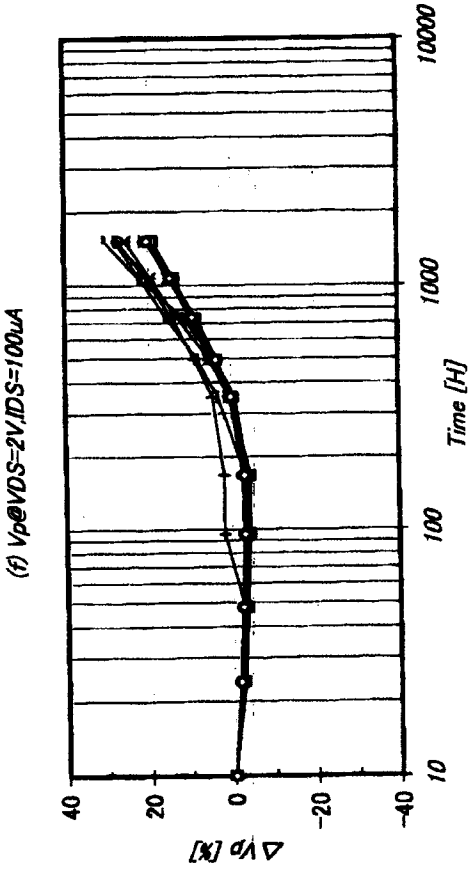


Figure 4-2. High Temperature Storage Test Results (Ta=259℃)

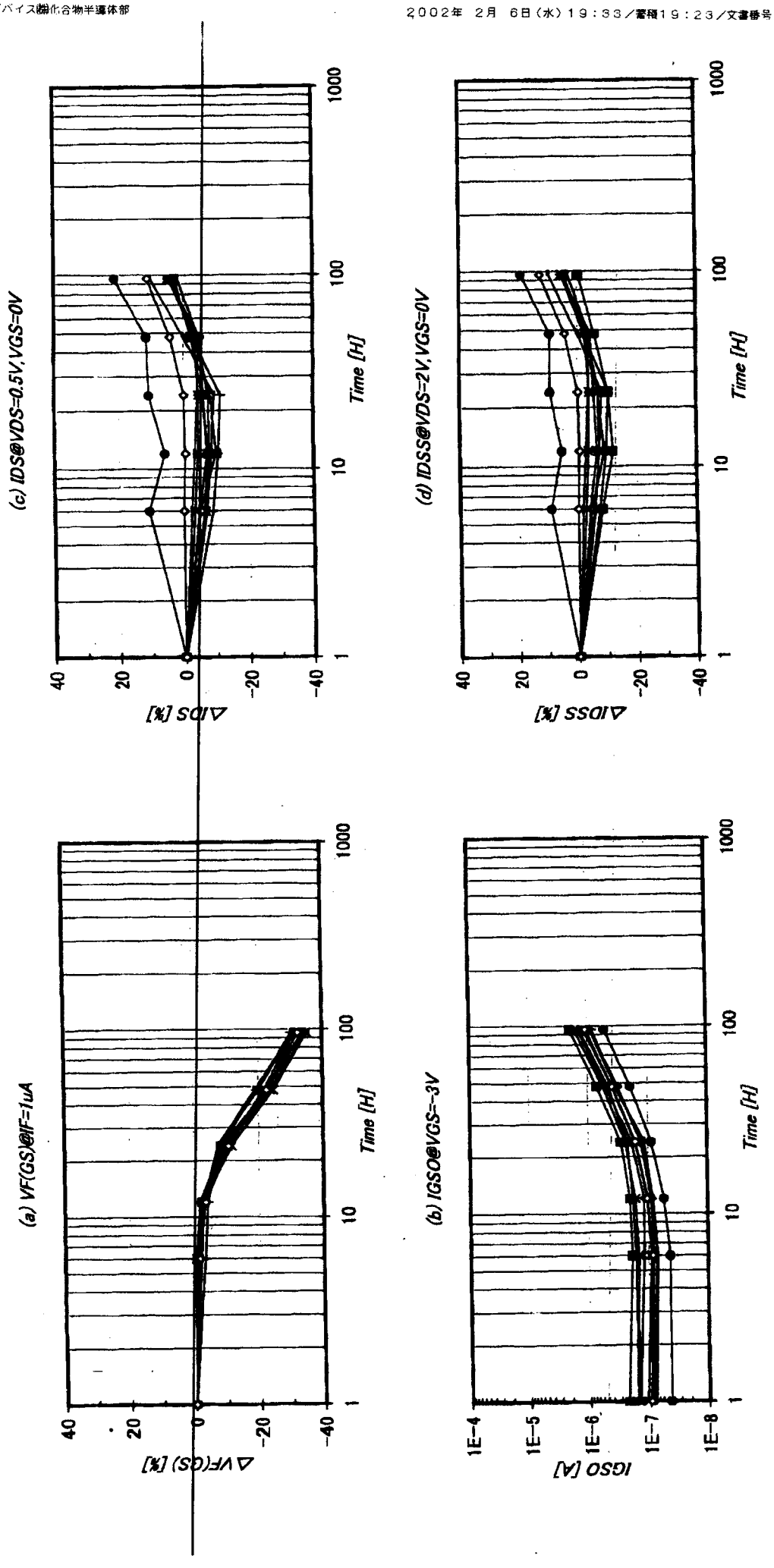


Figure 5-1. High Temperature Storage Test Results (Ta=295°C)

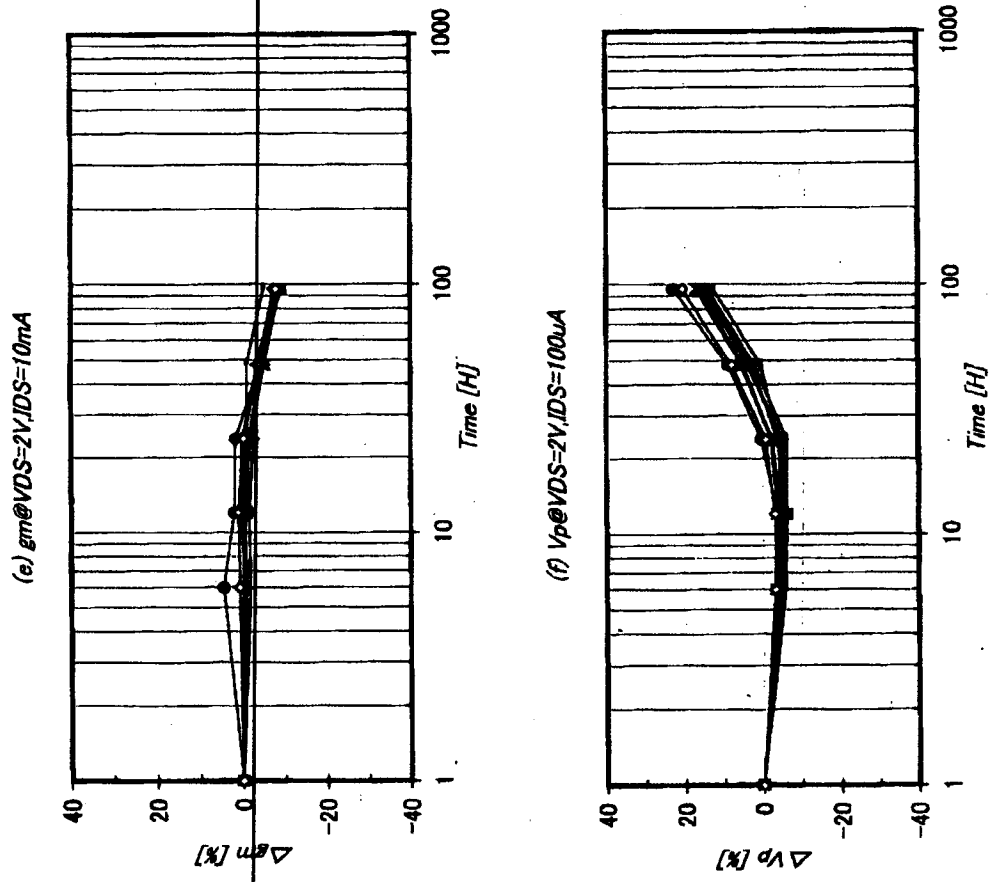


Figure 5-2: High Temperature Storage Test Results (Ta=295°C)

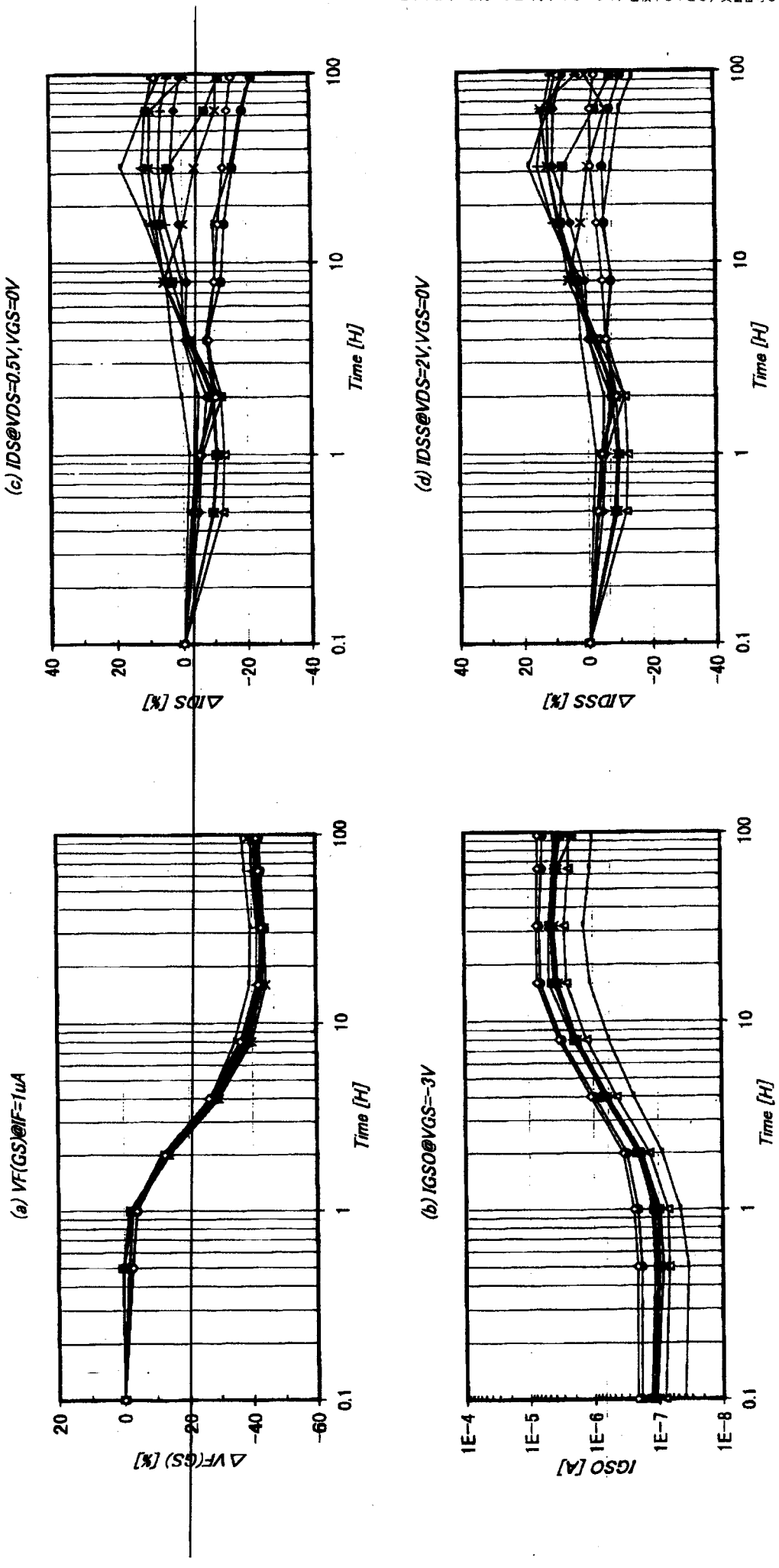
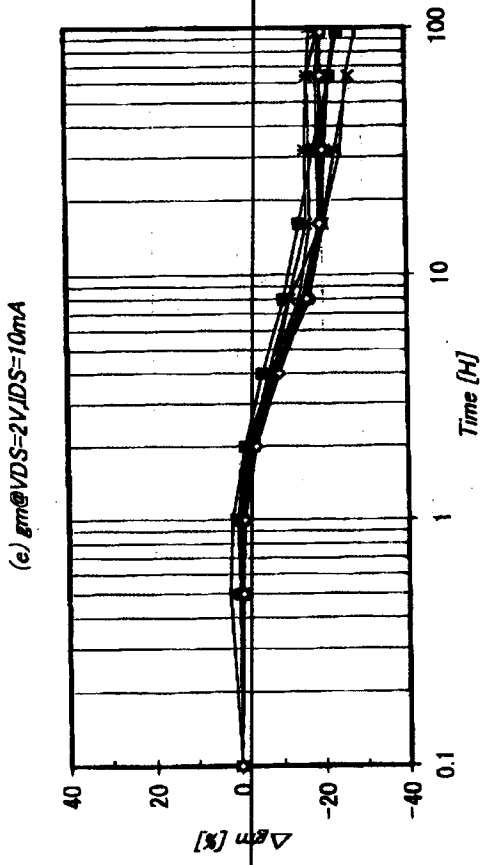


Figure 6-1. High Temperature Storage Test Results (Ta=337℃)



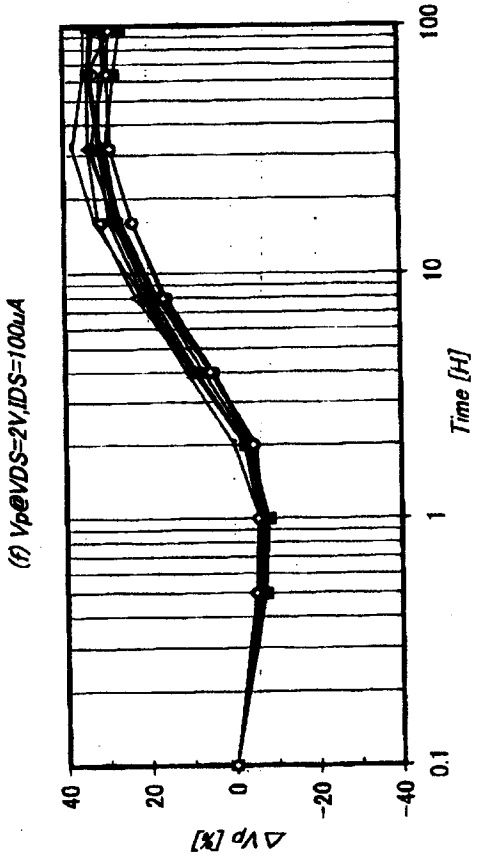


Figure 6-2. High Temperature Storage Test Results (Ta=337℃)

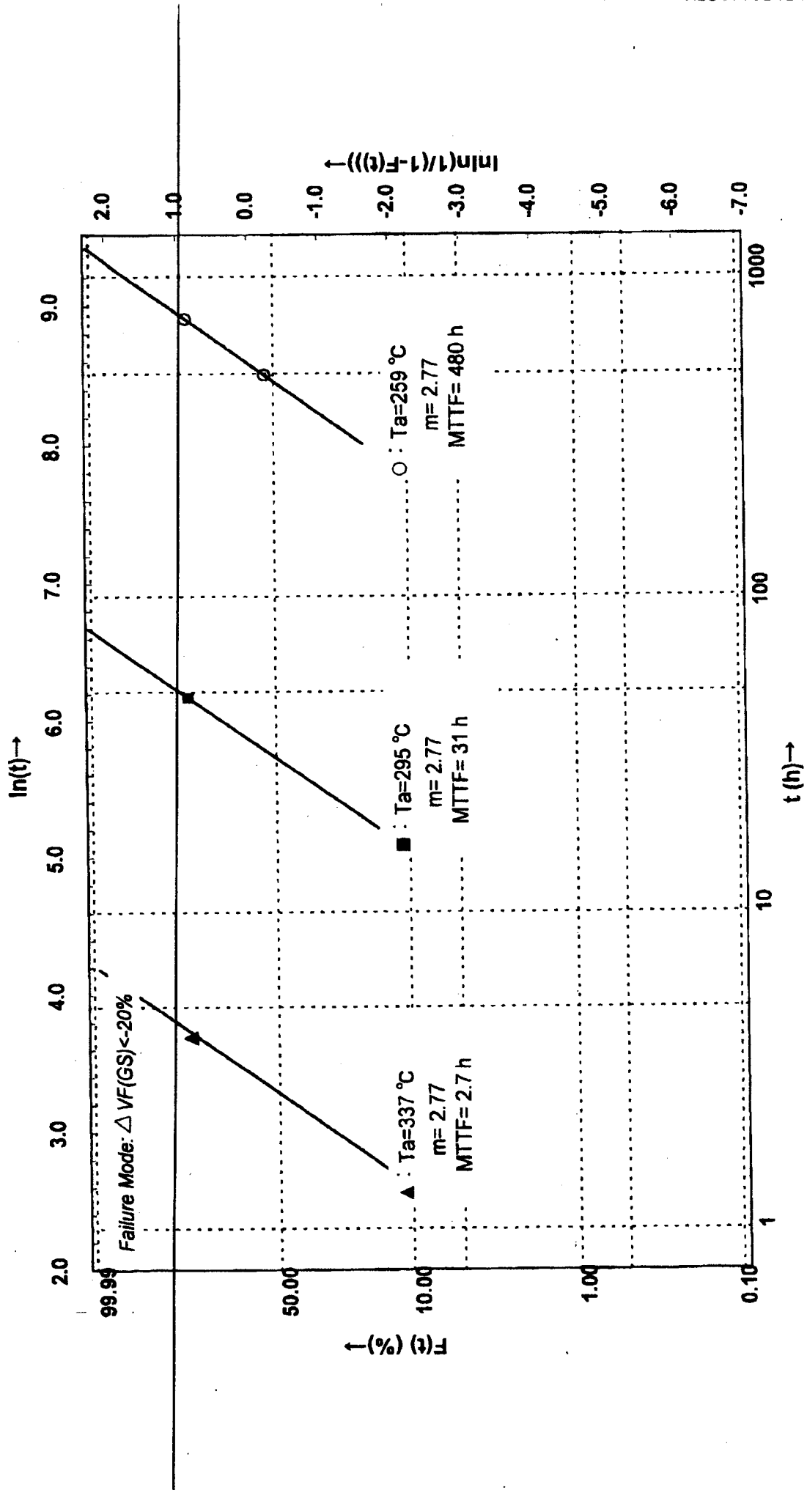


Figure 7 Weibull plots on High Temperature Storage Test Results

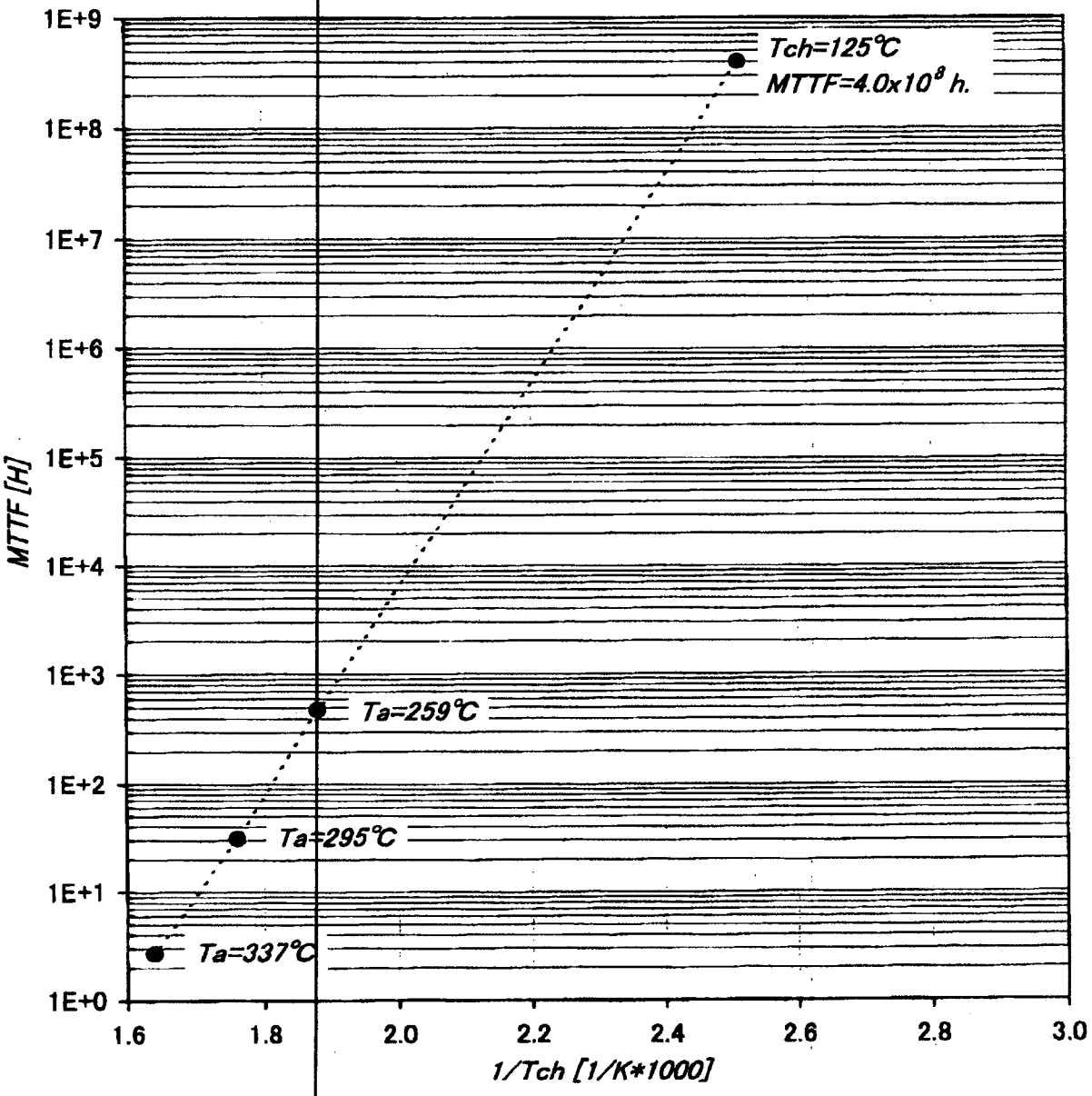


Figure 8. Arrhenius plots on High Temperature Storage Test Results