문제 1 : 2차원에서의 전기 전도도 - 답안지 *(10점)*

A 부분. 4점 탐침(4PP) 측정 (1.2점)

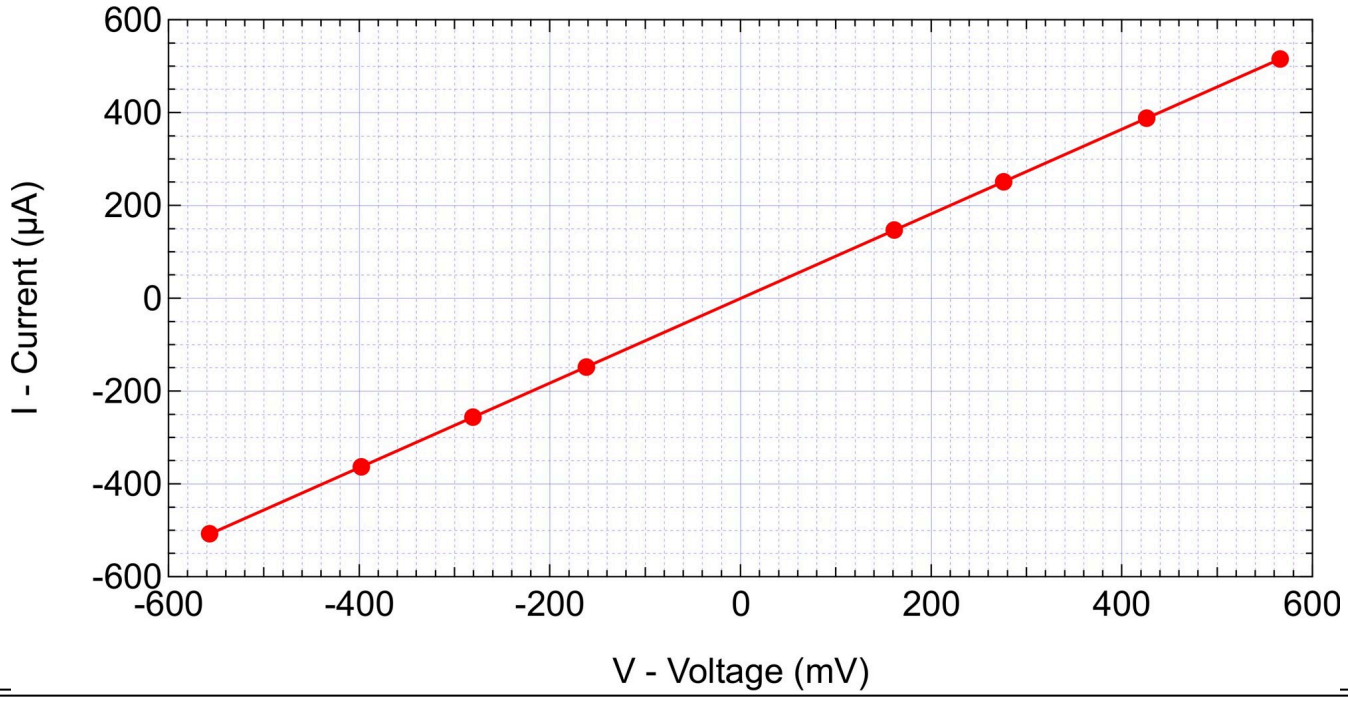
A1 (0.6 pts)

$s = 2$ cm

I (μA)	V (mV)	I (μA)	V (mV)
251	276	-148	-162
516	566	-256	-281
388	426	-363	-398
147	161	-507	-557

자료를 **그래프 B1** 에 그려라

그래프 B1: I 대 V



A2 (0.2 pts)

$R = 1.08$ kΩ

A3 (0.4 pts)

$\Delta R = \pm 1$ Ω

B 부분. 면 비저항 (0.3점)

B1 (0.3 pts)

$\rho_{\square} \equiv \rho_{\infty} = 4.89\ \mathrm{k\Omega}$

C 부분. 시료 크기를 바꾼 측정 (3.2점)

C1 (3 pts) 와 **C2 (0.2 pts)**

$s = 20$ mm

$\rho_\infty = 4.89$ kΩ

w/s	I (μA)	V (mV)	R(w/s) (kΩ)	$R_{average}$ (kΩ)		$\hat{R}$
0.3	92	1477	16.1	15.9		14.7
0.3	74	1184	16			
0.3	57	914	16			
0.3	41	651	15.9			
0.3	23	358	15.6			
0.5	154	1306	8.5	8.5		7.8
0.5	127	1079	8.5			
0.5	97	824	8.5			
0.5	67	567	8.5			
0.5	38	321	8.4			
1	233	1071	4.6	4.6		4.3
1	174	799	4.6			
1	135	621	4.6			
1	101	465	4.6			
1	59	271	4.6			
2.5	389	749	1.9	1.9		1.8
2.5	319	635	2			
2.5	237	457	1.9			
2.5	151	291	1.9			
2.5	74	143	1.9			
5	467	648	1.4	1.4		1.3
5	419	577	1.4			
5	363	499	1.4			
5	289	398	1.4			
5	185	254	1.4			

D 부분. 기하학적 보정 인자 (1.9점)

D1 (1.0 pts)

자료를 알맞은 모눈종이에 그려라: 선형(그래프 E1a), 반로그(D1b) **또는** 양쪽 로그(D1c). 모눈종이는 다음 쪽들에 있다.

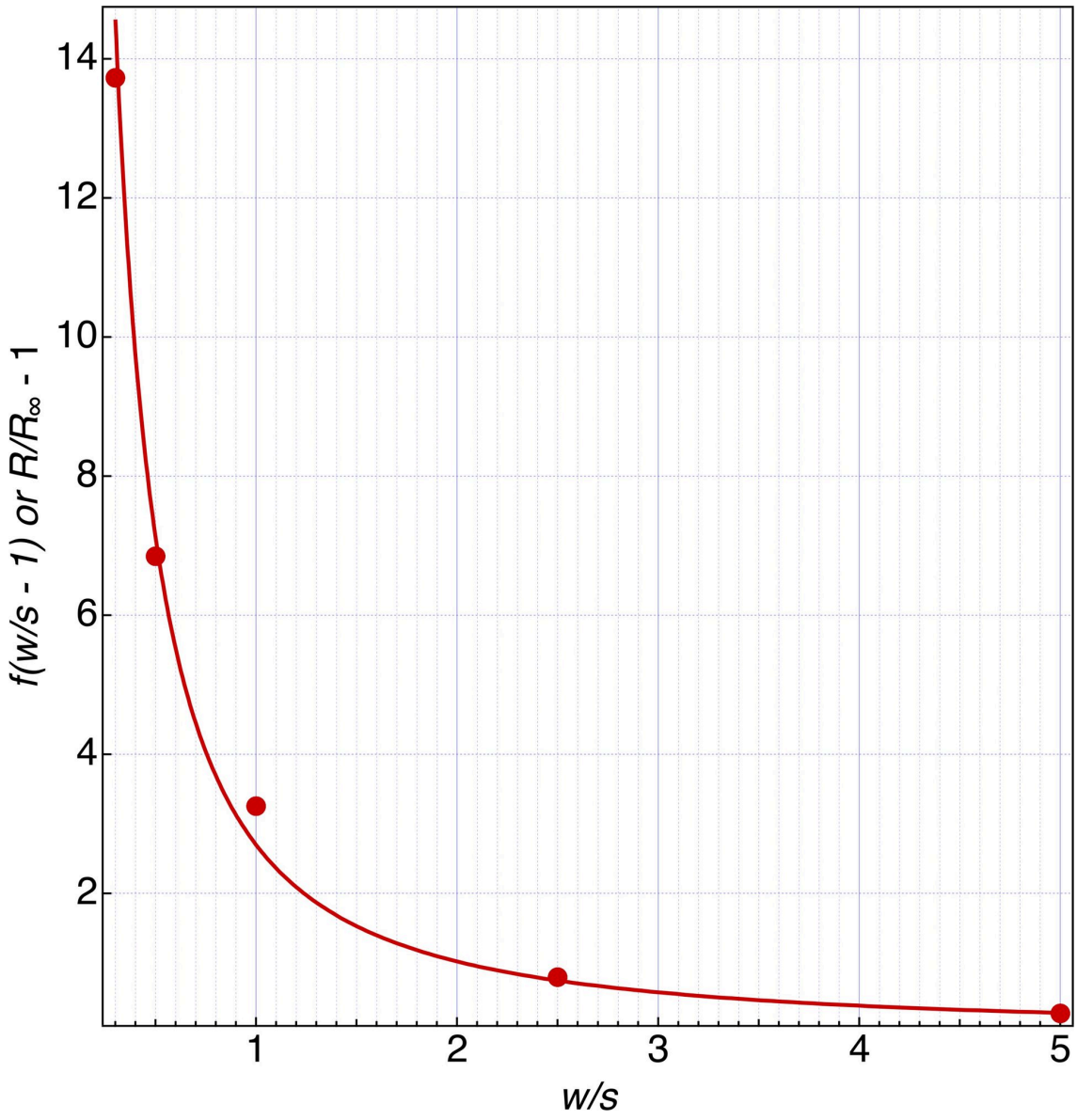
D2 (0.9 pts)

$a = 2.7$

$b = -1.4$

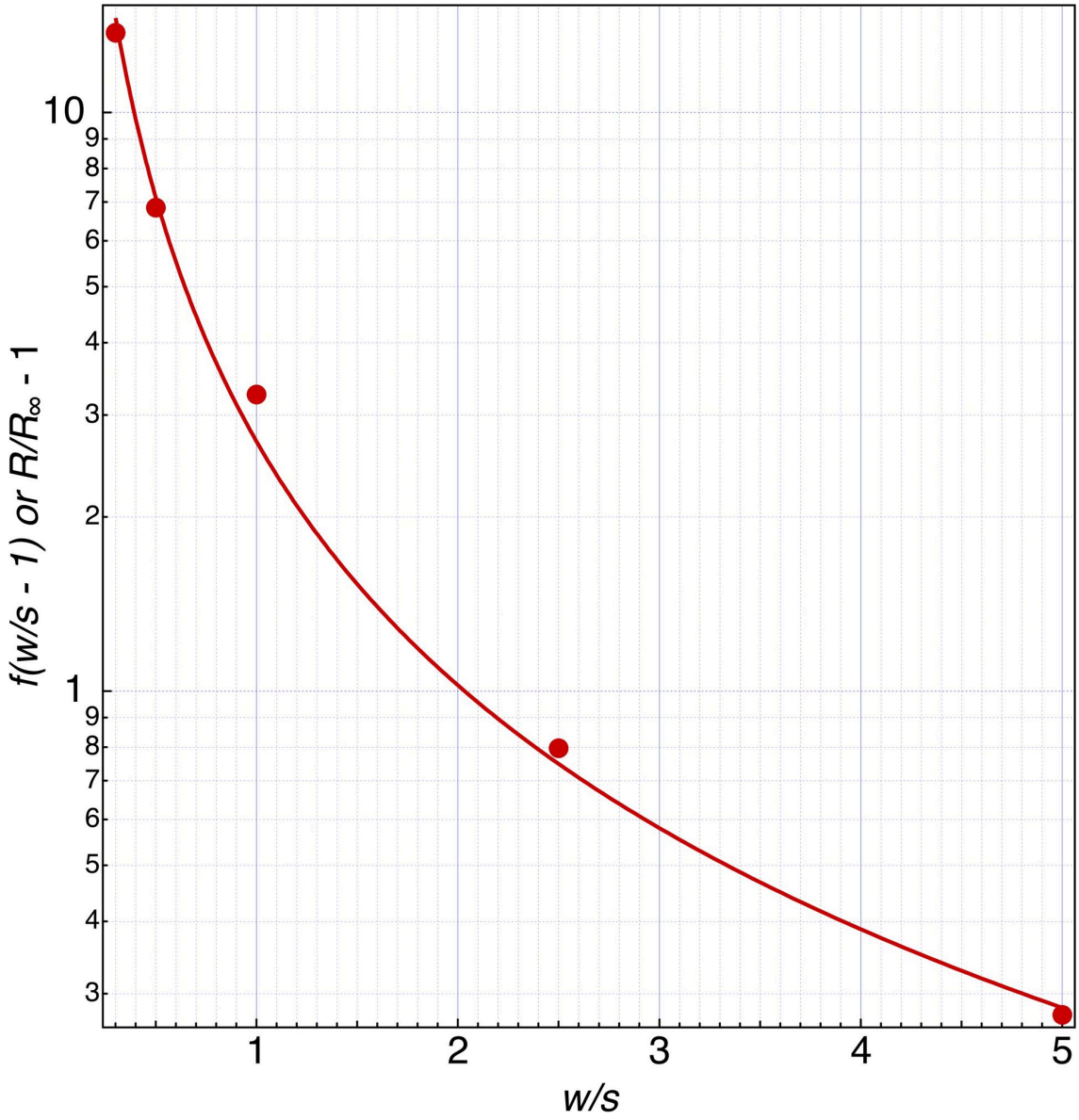
그래프 D1a: 선형 눈금: I 대 V

틀림. 선형 눈금을 쓰면 변수를 알아낼 수 없다.



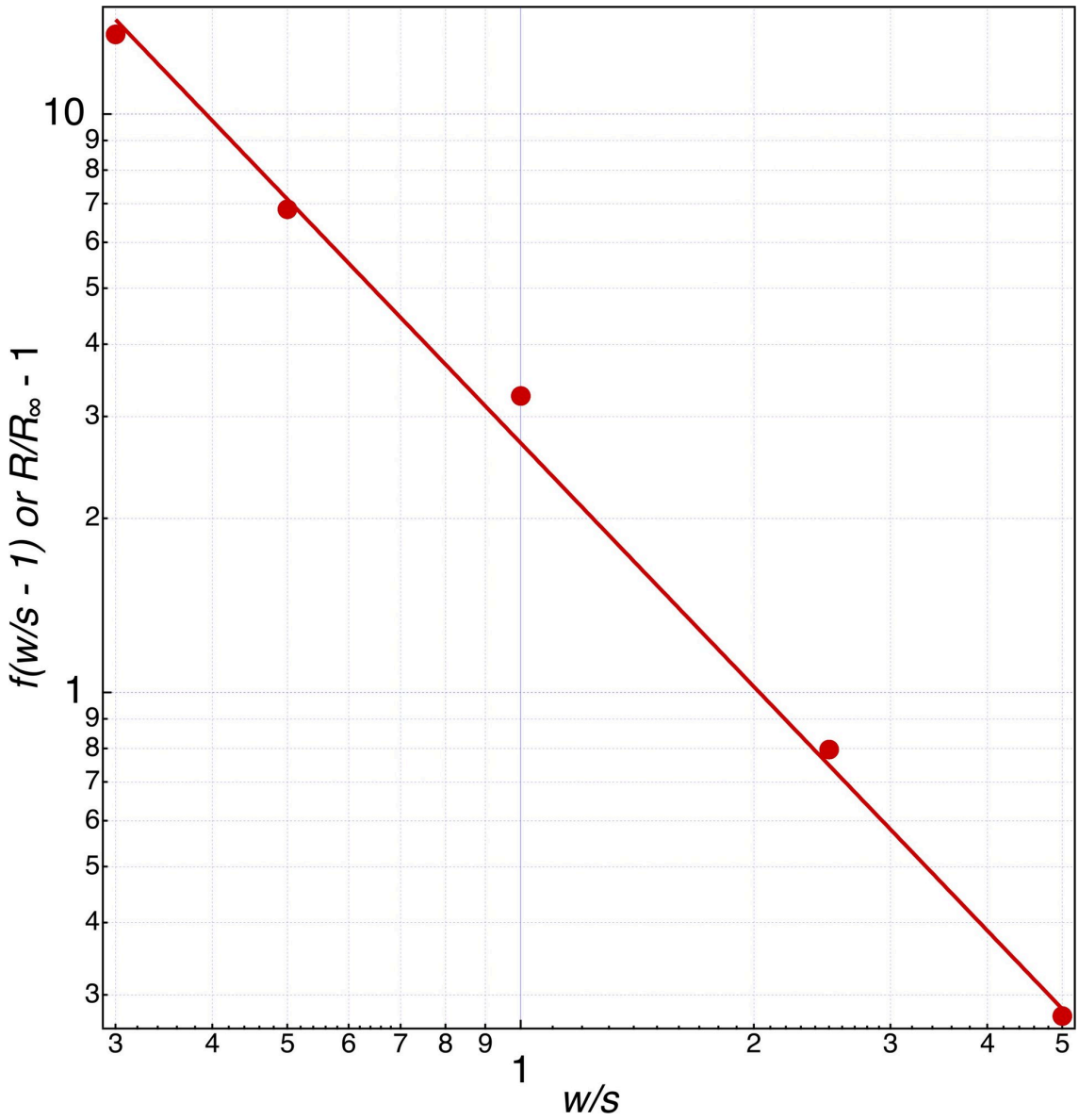
그래프 D1b: 반로그 눈금: I 대 V

틀림. 반로그 눈금을 쓰면 변수를 알아낼 수 없다.



그래프 D1c: 양쪽 로그 눈금: I 대 V

맞음. 직선을 맞추어 변수를 알아낼 수 있다.



E 부분. 판 데르 파우 방법 (3.4점)

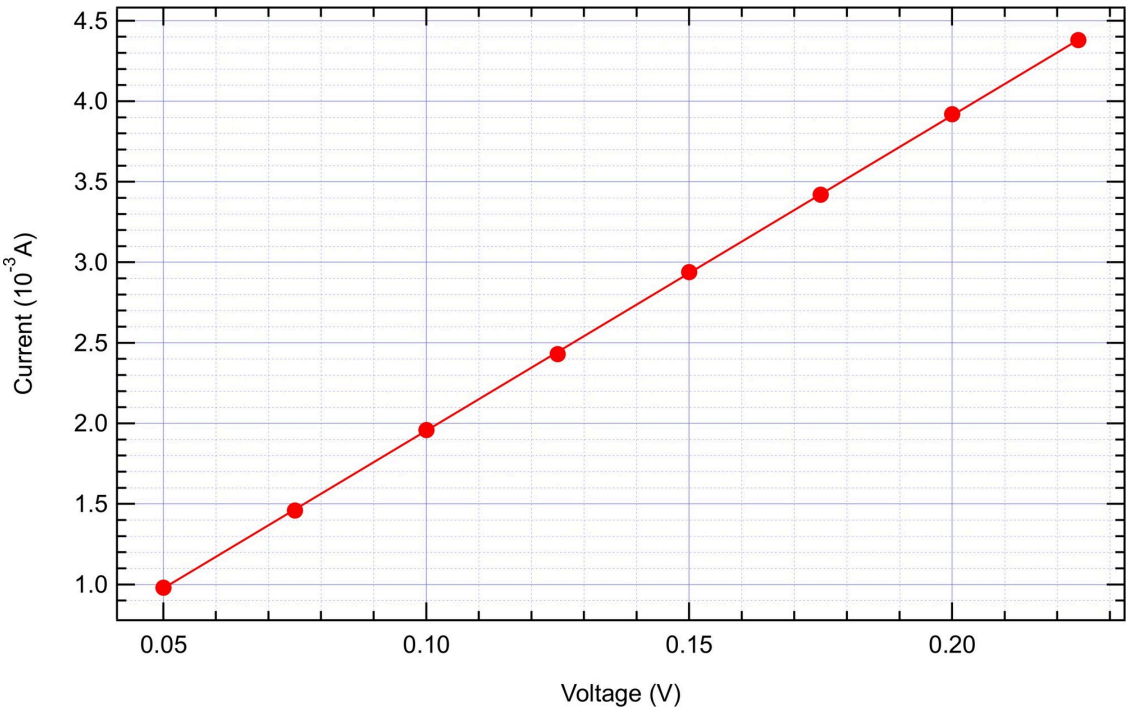
여기에 웨이퍼 번호를 적으시오: 99 (1 ~ 450 중)

E1 (0.4 pts)

I (mA)	V (mV)	I (mA)	V (mV)
0.98	50	2.94	150
1.46	75	3.42	175
1.96	100	3.92	200
2.43	125	4.38	224

E2 (0.4 pts)

그래프 F2: I 대 V



$R_{4PP} = 51.1\Omega$

E3 (0.2 pts)

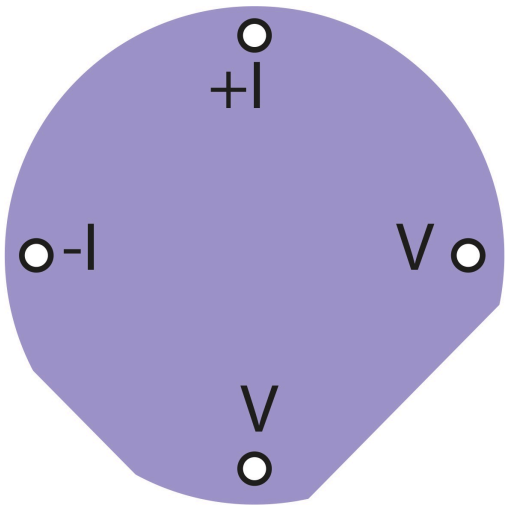
$w = 10$ cm $\rightarrow$ $w/s = 5$ $f(w/s) = 1.284$

E4 (0.1 pts)

$\rho_{\square} = 180\ \Omega$

E5 (0.6 pts)

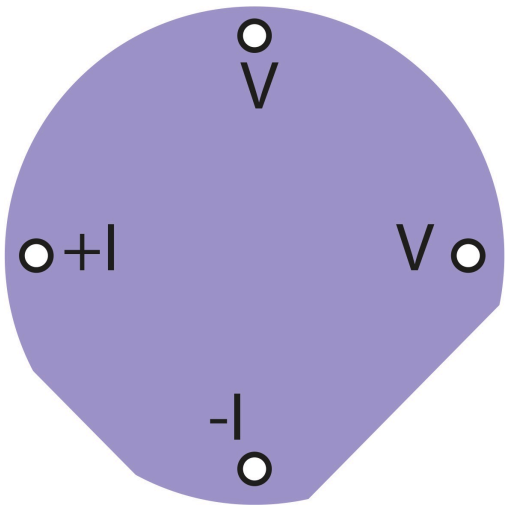
개형(전류의 방향):



V mV	*I* mA
140	3.71
120	3.18
100	2.66
80	2.12
60	1.58
40	1.06
20	0.53
-20	-0.54
-40	-1.06
-60	-1.61
-80	-2.13
-100	-2.68
-120	-3.2
-136	-3.62

E6 (0.6 pts)

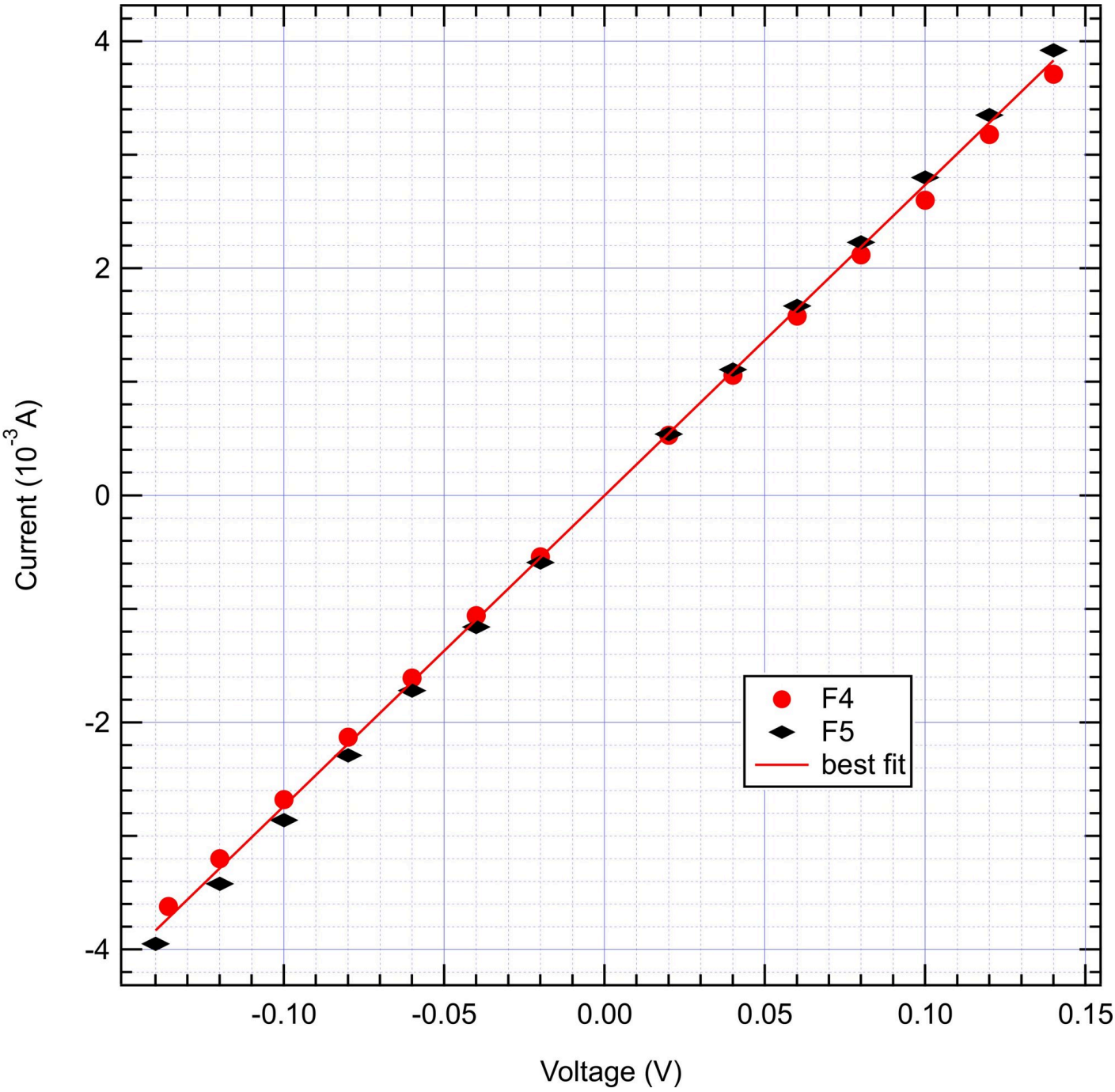
개형(전류의 방향):



I	*V*
140	3.92
120	3.35
100	2.8
80	2.23
60	1.67
40	1.11
20	0.54
-20	-0.59
-40	-1.16
-60	-1.72
-80	-2.29
-100	-2.86
-120	-3.42
-140	-3.95

E7 (0.5 pts)

그래프 F6: I 대 V



$\langle R \rangle = 36.5\ \Omega$

E8 (0.4 pts) 계산:

$2 \cdot e^{-\pi \cdot \langle R \rangle / \rho_\square} = 1$ $e^{-\pi \cdot \langle R \rangle / \rho_\square} = 1/2$

$-\dfrac{\pi \cdot \langle R \rangle}{\rho_\square} = \ln(1/2)$ $\dfrac{\pi \cdot \langle R \rangle}{\rho_\square} = \ln(2)$

$\rho_\square = \dfrac{\pi \cdot \langle R \rangle}{\ln(2)}$

$\rho_\square = 165\ \Omega$

E9 (0.1 pts)

$\frac{\Delta \rho_\square}{\rho_\square} =$ 0.091 $=$ 9.1 %

E10 (0.1 pts)

Cr 박막의 비저항 $\rho = 1.32 \cdot 10^{-6}\ \Omega \cdot \mathrm{m}$