Si Hall mobility

Neil Dilley

PPMS - ETO

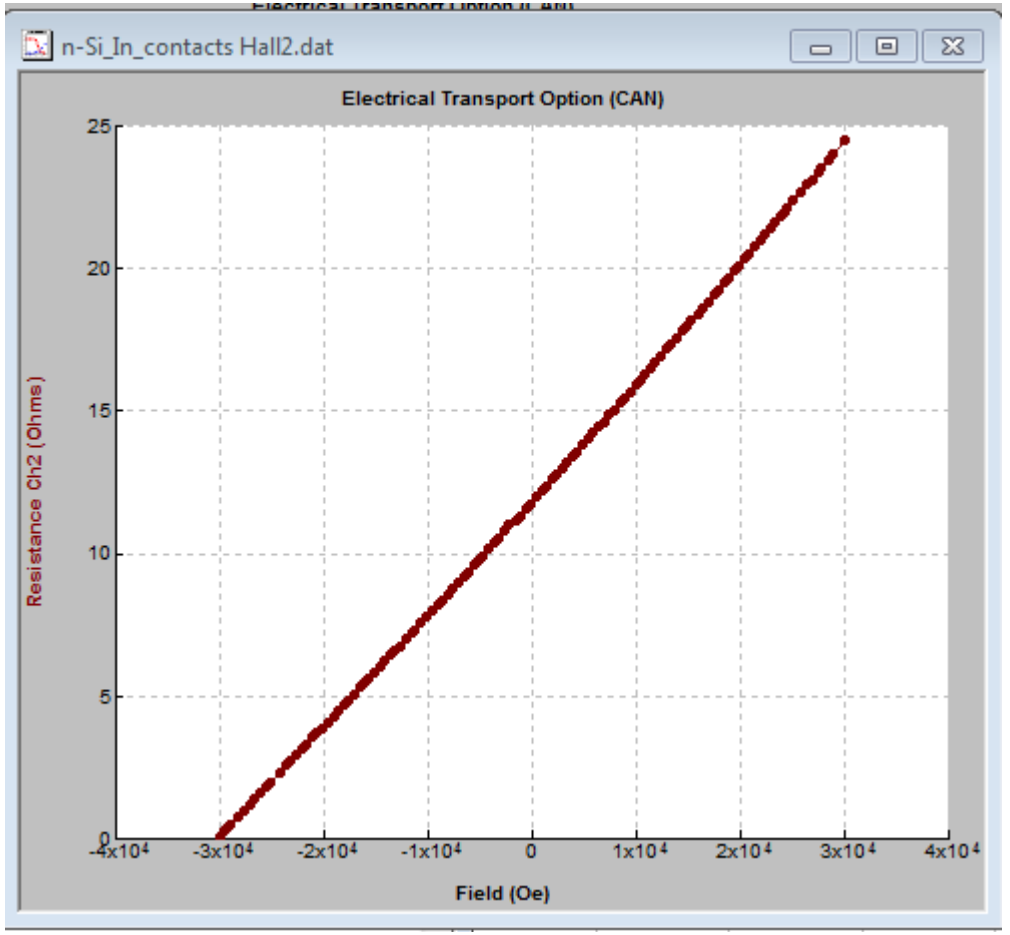
sample from Maria Jose Cadena

sample contacts: Cu wire, pressed indium

- bare Cu wire soldered to QD puck
- pressed indium contacts @ sample
  - scratched corner of sample w/ diamond scribe
  - rubbed In at scratch region
  - pressed/squashed In contact there
  - placed wire on this contact
  - pressed another In contact on top to sandwich the wire

carrier density and sign

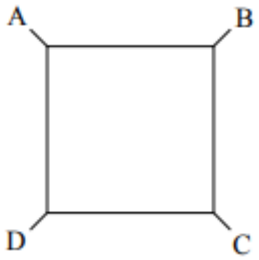
- t=0.37mm thick crystal
- slope > 0 → **p-doped Si**
- Hall coeff R_H = 1/ne
  - $R_H = \frac{\Delta R_{xy} t}{\Delta B}$
    = 24 ohms*0.037cm/6e4 Oe
    = 1.48e-5 ohm-cm/Oe
    = 1.48e3 cm^3/C (10^8 unit conv.)
  - n = 1/(R_He) = **4.2e15 holes/cm^3**
    - electron charge e=1.6e-19 C
  - near intrinsic levels, not doped!
    - must consider both carrier types...



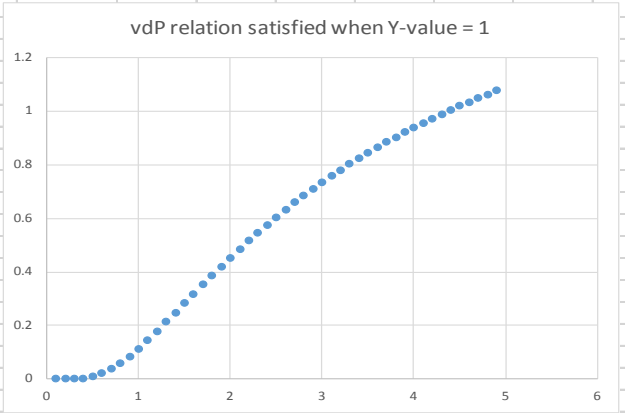
resistivity ρ : from van der Pauw relation

$$e^{-\pi t R_A/\rho} + e^{-\pi t R_B/\rho} = 1$$

- $R_A = R_{AB,CD}$: current A→B; voltage C→D
  - R_A = 20.8 ohm
- $R_B = R_{BC,DA}$
  - R_B = 32.6 ohm
- t = .037 cm
- solve by trial in Excel, find **rho = 4.4 ohm-cm**



0.1	3.98771E-11		d[cm]	0.037
0.2	6.32074E-06		R_A [ohm]	20.6
0.3	0.000344913		R_B [ohm]	32.6
0.4	0.002589797			
0.5	0.008831595			
0.6	0.020291422			
0.7	0.037144458			
0.8	0.058896373			
0.9	0.084747622			
1	0.113825688			
1.1	0.145307501			
1.2	0.178472661			
1.3	0.212718286			
1.4	0.247554687			
1.5	0.282592756			
1.6	0.317528819			
1.7	0.352129803			
1.8	0.386219927			
1.9	0.419669324			
2	0.452384586			
2.1	0.484301036			
2.2	0.515376503			
2.3	0.54558633			
2.4	0.574919396			
2.5	0.603374968			
2.6	0.630960203			
2.7	0.65768818			
2.8	0.683576349			
2.9	0.708645311			
3	0.732917866		**column A: trial values of rho**	
3.1	0.756418267		**column B: result of van der Pauw relation, seek value of 1**	
3.2	0.779171635			
3.3	0.801203513			
3.4	0.822539519			
3.5	0.843205084			
3.6	0.86322525			
3.7	0.882624527			
3.8	0.901426782			
3.9	0.919655166			
4	0.937332066			
4.1	0.954479071			
4.2	0.971116959			
4.3	0.987265694			
4.4	**1.00294443**			
4.5	1.018171526			
4.6	1.03296456			
4.7	1.047340354			
4.8	1.061314998			
4.9	1.07490387			



carrier mobility $\mu = (\rho ne)^{-1}$

- **μ = 334 cm^2/V-s**
  - rho = 4.4 ohm-cm
  - ne = 6.8e-4 C/cm^3
- (Kittel: hole mobility in Si = 500 cm^2/V-s)