实验二十三 高温超导材料特性测试和低温温度计 鲁祚汀2200011358

一、实验数据

将通过铂电阻、超导样品、硅二极管的电流分别设为1mA,10mA,100μA

1.在室温下测得铂电阻两端电压为109.65mV,即其电阻为109.65Ω，查表知室温T0=297.66K

2. 低温温度计比对实验数据与超导转变曲线实验数据记录如下：

表一：铂电阻、硅二极管、超导样品的电阻温度特性数据表

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| U铂/mV | U硅/mV | U超导/mV | R铂/Ω | R硅/kΩ | R超导/Ω | T/K |
| 107.91 | 0.5224 | 0.119 | 107.91 | 5.224 | 0.0119 | 293.19 |
| 104.28 | 0.5447 | 0.110 | 104.28 | 5.447 | 0.0110 | 283.88 |
| 101.86 | 0.5596 | 0.104 | 101.86 | 5.596 | 0.0104 | 277.69 |
| 99.67 | 0.5734 | 0.101 | 99.67 | 5.734 | 0.0101 | 272.09 |
| 96.58 | 0.5925 | 0.098 | 96.58 | 5.925 | 0.0098 | 264.22 |
| 93.78 | 0.6101 | 0.095 | 93.78 | 6.101 | 0.0095 | 257.10 |
| 90.10 | 0.6328 | 0.092 | 90.10 | 6.328 | 0.0092 | 247.76 |
| 85.93 | 0.6582 | 0.089 | 85.93 | 6.582 | 0.0089 | 237.22 |
| 82.31 | 0.6798 | 0.086 | 82.31 | 6.798 | 0.0086 | 228.10 |
| 77.96 | 0.7053 | 0.083 | 77.96 | 7.053 | 0.0083 | 217.19 |
| 73.93 | 0.7285 | 0.080 | 73.93 | 7.285 | 0.0080 | 207.12 |
| 70.35 | 0.7492 | 0.077 | 70.35 | 7.492 | 0.0077 | 198.20 |
| 65.67 | 0.7758 | 0.074 | 65.67 | 7.758 | 0.0074 | 186.57 |
| 61.77 | 0.7980 | 0.071 | 61.77 | 7.980 | 0.0071 | 176.93 |
| 58.54 | 0.8164 | 0.068 | 58.54 | 8.164 | 0.0068 | 168.98 |
| 54.89 | 0.8369 | 0.065 | 54.89 | 8.369 | 0.0065 | 160.02 |
| 51.32 | 0.8539 | 0.062 | 51.32 | 8.539 | 0.0062 | 151.30 |
| 48.32 | 0.8745 | 0.060 | 48.32 | 8.745 | 0.0060 | 144.00 |
| 44.81 | 0.8930 | 0.057 | 44.81 | 8.930 | 0.0057 | 135.51 |
| 41.27 | 0.9124 | 0.054 | 41.27 | 9.124 | 0.0054 | 126.99 |
| 37.75 | 0.9316 | 0.052 | 37.75 | 9.316 | 0.0052 | 118.57 |
| 35.94 | 0.9414 | 0.050 | 35.94 | 9.414 | 0.0050 | 114.26 |
| 33.76 | 0.9531 | 0.048 | 33.76 | 9.531 | 0.0048 | 109.08 |
| 32.17 | 0.9617 | 0.046 | 32.17 | 9.617 | 0.0046 | 105.32 |
| 30.15 | 0.9724 | 0.044 | 30.15 | 9.724 | 0.0044 | 100.55 |
| 28.67 | 0.9803 | 0.042 | 28.67 | 9.803 | 0.0042 | 97.073 |
| 27.74 | 0.9852 | 0.040 | 27.74 | 9.852 | 0.0040 | 94.889 |
| 27.71 | 0.9855 | 0.039 | 27.71 | 9.855 | 0.0039 | 94.819 |
| 27.67 | 0.9858 | 0.038 | 27.67 | 9.858 | 0.0038 | 94.725 |
| 27.63 | 0.9860 | 0.036 | 27.63 | 9.860 | 0.0036 | 94.631 |
| 27.61 | 0.9861 | 0.035 | 27.61 | 9.861 | 0.0035 | 94.584 |
| 27.60 | 0.9862 | 0.034 | 27.60 | 9.862 | 0.0034 | 94.561 |
| 27.59 | 0.9863 | 0.032 | 27.59 | 9.863 | 0.0032 | 94.537 |
| 27.58 | 0.9863 | 0.030 | 27.58 | 9.863 | 0.0030 | 94.514 |
| 27.57 | 0.9864 | 0.026 | 27.57 | 9.864 | 0.0026 | 94.490 |
| 27.56 | 0.9864 | 0.019 | 27.56 | 9.864 | 0.0019 | 94.467 |
| 27.55 | 0.9864 | 0.013 | 27.55 | 9.864 | 0.0013 | 94.443 |
| 27.55 | 0.9865 | 0.008 | 27.55 | 9.865 | 0.0008 | 94.430 |
| 27.54 | 0.9865 | 0.004 | 27.54 | 9.865 | 0.0004 | 94.420 |
| 27.53 | 0.9866 | 0.002 | 27.53 | 9.866 | 0.0002 | 94.396 |
| 27.52 | 0.9866 | 0.001 | 27.52 | 9.866 | 0.0001 | 94.373 |
| 27.51 | 0.9867 | 0.000 | 27.51 | 9.867 | 0.0000 | 94.349 |
| 26.37 | 0.9928 | 0.000 | 26.37 | 9.928 | 0.0000 | 91.678 |
| 25.76 | 0.9959 | 0.000 | 25.76 | 9.959 | 0.0000 | 90.249 |
| 24.94 | 1.0000 | 0.000 | 24.94 | 10.000 | 0.0000 | 88.329 |
| 24.55 | 1.0020 | 0.000 | 24.55 | 10.020 | 0.0000 | 87.417 |
| 24.00 | 1.0052 | 0.000 | 24.00 | 10.052 | 0.0000 | 86.130 |
| 23.50 | 1.0077 | 0.000 | 23.50 | 10.077 | 0.0000 | 84.961 |
| 23.00 | 1.0103 | 0.000 | 23.00 | 10.103 | 0.0000 | 83.792 |
| 22.00 | 1.0158 | 0.000 | 22.00 | 10.158 | 0.0000 | 81.453 |
| 21.00 | 1.0207 | 0.000 | 21.00 | 10.207 | 0.0000 | 79.112 |
| 20.40 | 1.0239 | 0.000 | 20.40 | 10.239 | 0.0000 | 77.706 |
| 20.34 | 1.0242 | 0.000 | 20.34 | 10.242 | 0.0000 | 77.565 |

3.最终铂电阻两端电压不再变化，且温差电偶温度计示零，说明温度达到液氮沸点。

铂电阻两端电压为20.34mV,即其电阻为20.34Ω，查表知液氮沸点TN=77.565K

二、实验数据的分析、处理和结论

1. 室温T0=297.66K，在室温下：

测得通过铂电阻、超导样品、硅二极管的电流分别为1.0000mA, 10.0215mA, 100.00μA

铂电阻、超导样品、硅二极管两端的电压分别为109.65mV, 0.115mV, 0.5115V，那么其室温下的电阻分别为109.65Ω，0.0115Ω，5.115kΩ

2.画出铂电阻和硅二极管温度计的电阻温度特性曲线

铂的电阻基本随温度下降而线性减小

硅二极管的电阻基本随温度下降而线性增大

R=0.4051T-10.2205,r=0.99994

3.根据实验数据作出样品的超导转变曲线

由于刚开始测量时，系统可能温度不均匀，所以去除最右侧的两个数据点

经过最小二乘法拟合得两条直线：R=3.2543\*T+1.2419\*, r=0.9991

R=0.008296T-0.7820，r=0.89

得到起始转变温度为Tc,onset=94.889K, 零电阻温度Tc0=94.349K

超导转变温度Tcm=94.519K

4. 最终铂电阻两端电压不再变化，且温差电偶温度计示零，说明温度达到液氮沸点。

铂电阻两端电压为20.34mV,即其电阻为20.34Ω，查表知液氮沸点TN=77.565K

硅二极管两端电压为1.0242V,电阻为10.242kΩ

在液氮沸点下，测得通过铂电阻、超导样品、硅二极管的电流分别为0.9999mA, 10.0207mA, 100.03μA， 与室温下的数据偏差小于0.03%，可以认为系统的电流是稳定的