计算铝棒的电阻率

$$
\begin{aligned}
\overline{R_3} &= \frac{1}{4}(R_{3上} + R_{3下} + R'_{3上} + R'_{3下}) \\
&= \frac{1}{4}(11.45 + 12.46 + 12.42 + 11.47) \\
&= 11.95\Omega, \\
\overline{d} &= \frac{1}{5}\sum d \\
&= \frac{1}{5}(4.035 + 4.031 + 4.043 + 4.038 + 4.033) \\
&= 4.036\mathrm{mm}, \\
\overline{R_x} &= \frac{R_N}{R_1}\overline{R_3} \\
&= \frac{0.01}{10^2}11.95 \\
&= 1.195 * 10^{-3}\Omega, \\
\overline{\rho} &= \frac{\pi\overline{d}^2}{4l}\overline{R_x} \\
&= \frac{3.1416 * 4.036^2}{4 * 400.0}1.195 * 10^{-3} \\
&= 3.822 * 10^{-5}\Omega\cdot\mathrm{mm}.
\end{aligned}
$$

计算铜棒的电阻率

$$
\begin{aligned}
\overline{R_3} &= \frac{1}{4}(R_{3\text{上}} + R_{3\text{下}} + R'_{3\text{上}} + R'_{3\text{下}}) \\
&= \frac{1}{4}(22.43 + 23.44 + 23.45 + 22.48) \\
&= 22.95\Omega, \\
\overline{d} &= \frac{1}{5}\sum d \\
&= \frac{1}{5}(3.973 + 3.978 + 3.976 + 3.975 + 3.978) \\
&= 3.976\text{mm}, \\
\overline{R_x} &= \frac{R_N}{R_1}\overline{R_3} \\
&= \frac{0.01}{10^2}22.95 \\
&= 2.295 * 10^{-3}\Omega, \\
\overline{\rho} &= \frac{\pi\overline{d}^2}{4l}\overline{R_x} \\
&= \frac{3.1416 * 3.976^2}{4 * 400.0}2.295 * 10^{-3} \\
&= 8.513 * 10^{-5}\Omega \cdot \text{mm}.
\end{aligned}
$$

计算铁棒的电阻率

$$
\begin{aligned}
\overline{R_3} &= \frac{1}{4}(R_{3上} + R_{3下} + R'_{3上} + R'_{3下}) \\
&= \frac{1}{4}(42.77 + 43.83 + 44.11 + 42.85) \\
&= 43.39\Omega, \\
\overline{d} &= \frac{1}{5}\sum d \\
&= \frac{1}{5}(3.995 + 3.996 + 3.989 + 3.994 + 3.991) \\
&= 3.993\text{mm}, \\
\overline{R_x} &= \frac{R_N}{R_1}\overline{R_3} \\
&= \frac{0.01}{10^2}43.39 \\
&= 4.339 * 10^{-3}\Omega, \\
\overline{\rho} &= \frac{\pi\overline{d}^2}{4l}\overline{R_x} \\
&= \frac{3.1416 * 3.993^2}{4 * 400.0}4.339 * 10^{-3} \\
&= 1.623 * 10^{-4}\Omega \cdot \text{mm}.
\end{aligned}
$$

计算铝棒电阻率的不确定度

$$
\begin{aligned}
U_{\overline{R_3}} &= \frac{1}{4}(|R_{3上} - R_{3下}| + |R'_{3上} - R'_{3下}|) \\
&= \frac{1}{4}(|11.45 - 12.46| + |12.42 - 11.47|) \\
&= 1.96\Omega, \\
U_{\overline{R_x}} &= \frac{R_N}{R_1}U_{\overline{R_3}} \\
&= \frac{0.01}{10^2}1.96 \\
&= 1.96 * 10^{-4}\Omega. \\
U_{\overline{d}} &= \sqrt{U_{dA}^2 + U_{dB}^2} \\
&= \sqrt{\frac{t_p^2}{4 * 5}\sum(\overline{d} - d)^2 + \left(\frac{0.01}{2 * 3}\right)^2}
\end{aligned}
$$

$$\sqrt{1.14^2 \ldots \left(0.01\right.^2}$$

$$
\begin{aligned}
&= \sqrt{\frac{}{4*5}(0.001^2 + 0.005^2 + 0.007^2 + 0.002^2 + 0.003^2) + \left(\frac{}{2*3}\right)} \\
&= 3*10^{-3}\text{mm}. \\
U_l &= U_{lB} \\
&= \frac{1}{2*3} \\
&= 0.2\text{mm}. \\
\ln\overline{\rho} &= \ln\frac{\pi\overline{d}^2}{4l}\overline{R_x} \\
&= 2\ln\overline{d} + \ln\overline{R_x} - \ln l + \ln\pi - \ln 4, \\
\frac{U_{\overline{\rho}}}{\overline{\rho}} &= \sqrt{\left(\frac{\partial\ln\overline{\rho}}{\partial\overline{d}}U_{\overline{d}}\right)^2 + \left(\frac{\partial\ln\overline{\rho}}{\partial\overline{R_x}}U_{\overline{R_x}}\right)^2 + \left(\frac{\partial\ln\overline{\rho}}{\partial l}U_l\right)^2} \\
&\sqrt{4\left(\frac{U_{\overline{d}}}{\overline{d}}\right)^2 + \left(\frac{U_{\overline{R_x}}}{\overline{R_x}}\right)^2 + \left(\frac{U_l}{l}\right)^2} \\
&\sqrt{4\left(\frac{3*10^{-3}}{4.036}\right)^2 + \left(\frac{1.96*10^{-4}}{1.195*10^{-3}}\right)^2 + \left(\frac{0.2}{400.0}\right)^2} \\
&= 0.2, \\
U_{\overline{\rho}} &= \frac{U_{\overline{\rho}}}{\overline{\rho}}\overline{\rho} \\
&= 0.2*3.822*10^{-5} \\
&= 8*10^{-6}\Omega\cdot\text{mm}. \\
\rho &= \overline{\rho} \pm U_{\overline{\rho}} \\
&= 3.822*10^{-5} \pm 8*10^{-6} \\
&= (38 \pm 8)*10^{-6}\Omega\cdot\text{mm}.
\end{aligned}
$$