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Temperature dependent resistivity in Rb3C60: constant volume versus constant pressure

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Under conditions of constant sample volume the normal state resistivity of ρ of Rb_3C_{60} has a temperature dependence $\rho \sim T$, in sharp contrast to $\rho \sim T^2$ observed under conditions of constant sample pressure. Implications for the normal-state scattering mechanism are discussed.

Previous studies[1] have shown that the temperature dependence of the resistivity for the doped fullerenes, measured at constant sample pressure, varies as

$$\rho(T) \approx a + bT^2 \quad (1)$$

from $T \approx 100$ K to well above room temperature. Most theoretical calculations of transport coefficients assume a constant sample volume, not constant sample pressure. External hydrostatic pressure has a significant influence on the normal state resistivity of Rb_3C_{60}[2] . Here we report on measurements of $\rho(T)$ in the normal state of Rb_3C_{60} measured at constant sample volume.

Single-crystal Rb_3C_{60} samples used in this study were prepared following a standard method[1]. Ambient pressure measurements displayed the characteristic $\rho_p(T) \sim T^2$ temperature dependence. Constant volume measurements were performed in a pressure cell at pressures up to 8kbar. In a typical temperature-dependent run, the cell was initially pressurized and clamped at room temperature and then the sample resistivity was measured as a function of temperature. To determine the constant-volume resistivity of the sample we exploited the natural pressure drop in the cell with decreasing temperature (which largely compensated for the thermal contraction of the sample). Additional corrections were made to the data using the thermal expansion coefficient ($d\ln(a)/dT = 3.05 \times 10^{-5}\ K^{-1}$ [3]) and the bulk modulus of Rb_3C_{60} (B = 219 kbar[4]).

Fig. 1 shows the normalized constant-volume resistivity for Rb_3C_{60}. The resistivity is **linear** in temperature between 100 K and 350 K! Hence, for constant sample volume, we find

$$\rho_v(T) \approx \alpha + \beta T \quad (2)$$

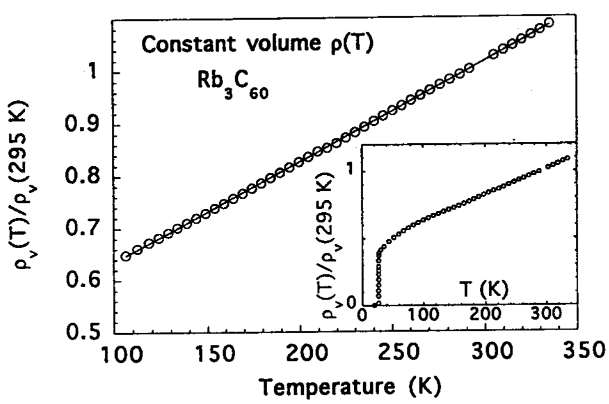

Figure 1. Constant volume and constant pressure normal state resistivity of Rb_3C_{60} normalized at 100 K.

in sharp contrast to Eq. (1), $\rho_p(T) \approx a + bT^2$, relevant to constant sample pressure.

To show the dramatic difference between the constant pressure and constant volume normal state resistivities, we plot in Fig. 2 $\rho_v(T)$ and $\rho_p(T)$. These data have been normalized to one another at 100K.

In the high temperature regime the slope of the $\rho_v(T)$ curve, $d\rho/dT$, is related to the transport el-ph coupling constant, λ_{tr}, by

$$\lambda_{tr} = \frac{\hbar\omega_p^2}{8\pi^2 k_B}\frac{d\rho}{dT} = 0.246(\hbar\omega_p)^2\frac{d\rho}{dT} \quad (3)$$

with units $[d\rho/dT] = \mu\Omega$-cm/ K, and $[h\omega_p/2\pi]$ = eV. With $d\rho/dT$ = 0.95 -1.1 $\mu\Omega$-cm/K and $\omega_p \approx 0.93$-1.67 eV [5] we find a range for the transport coupling constant of $\lambda_{tr} \approx 0.2 - 0.75$. It is important to realize that Eq. (3) determines λ_{tr} completely from experimentally measured quantities and that the range of values obtained is characteristic of a typical superconductor.

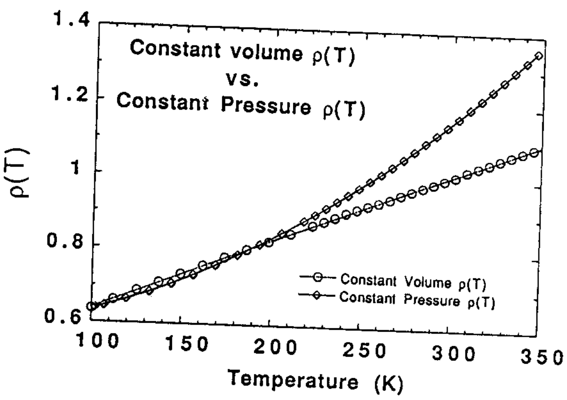

Figure 2. Normalized constant volume and constant pressure resistivities of Rb_3C_{60} in the normal state above 100K.

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References

1. X.-D. Xiang, *et al.*, Science 56 (1992) 1190-1.
2. W.A. Vareka and A. Zettl (to be published)
3. O. Zhou, et al., Novel Forms of Carbon, C.L. Renschler, J.J. Pouch, and D.M. Cox, Edsl, (Mat. Res. Soc. San Francisco, 1992) vol. 270, p. 191
4. O. Zhou, *et al.*, Science 55 (1992) 833-5.
5. L. Degiorgi, *et al.*, Physical Review B (Condensed Matter) 46 (1992) 11250-3.