Comment on "Universal Disorder-Induced Transition in the Resistivity Behavior of Strongly Coupled Metals"

Recently, Gurvitch[1] has speculated that there is a universal disorder-induced resistivity [$\rho(T)$] behavior of strongly coupled metals (with large electron-phonon coupling constant λ). We find that his explanation for universality of $\rho(T)$ behavior is inadequate for the following reasons.

(1) According to the Gurvitch model, a low-T_c compound like A-15 Ti_3Sb ($T_c = 6.5$ K) should not show a T^2 dependence of resistivity at low temperatures. However, the experiments[2,3] have shown that the $\rho(T)$ of Ti_3Sb indeed shows a T^2 behavior from above T_c to 35 K. Since the λ of Ti_3Sb is about 0.7, its $\rho(T)$ will not fall in the T^2 region in the Gurvitch plot. This will be true even if Ti_3Sb has a large residual resitivity $\rho(0)$.

(2) We find that Gurvitch has not mentioned the recent model proposed by Kaveh and Wiser[4] to explain the T^2 dependence of $\rho(T)$ of high-T_c A-15 compounds. According to Kaveh and Wiser, this T^2 dependence of $\rho(T)$ is due to electron-electron interaction enhanced by phonon-mediation effects. This effect is expected to weaken at about $\theta_D/10$ and hence the limited temperature range ($\theta_D = 300$–400 K) in which such a power law is observed. This phonon-mediated electron-electron interaction is very weak in low-T_c compounds and, hence, their $\rho(T)$'s do not exhibit T^2 dependence. In fact, they have claimed that their model agrees with the data obtained by Gurvitch *et al.*[5,6] on several A-15 compounds.

(3) According to Gurvitch, spin fluctuations are important in VN [which he inferred from his universal curve λ vs $\rho(0)$] which agrees with the theoretical prediction of Rietschel, Winter, and Reichardt.[7] Rietschel and Winter have shown[8] that spin fluctuations are also important in pure Nb and found the value of λ to be 1.2. From the Gurvitch[1] curve, one can see that the $\rho(T)$ of Nb should fall in the T^2 region when $\rho(0)$ reaches 40 $\mu\Omega \cdot$cm. According to Testardi, Poate, and Levinstein,[9] T_c of Nb is hardly affected by disorder. T_c decreases by about 0.2 K when $\rho(0)$ increases from 0.15 to 35 $\mu\Omega \cdot$cm. Hence, one can assume that λ does not decrease with disorder (similar to VN). However, there is no evidence so far that there is a T^2 dependence of $\rho(T)$ of disordered Nb at low temperatures.

(4) We also found that the resistivity of Nb_3Pt[10] does not agree completely with the model proposed by Gurvitch. Although it is true that the $\rho(T)$ of as-cast Nb_3Pt shows a T^5 law, the $\rho(T)$ of heat-treated Nb_3Pt shows a T^3 law at lowest T (12–27 K) and a T^2 law at higher temperatures (24–43 K). Further, our results[11] indicate that $\rho(T)$ of Nb_3Au also shows a T^2 behavior.

Hence, we feel that at this stage, one has to collect more data on the resistivity behavior of other A-15 compounds before using the universal curve proposed by Gurvitch to estimate the electron-phonon coupling constant λ.

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