Comment on "Evidence for a Common High-Temperature Superconducting Effect in $La_{1.85}Sr_{0.15}CuO_4$ and $YBa_2Cu_3O_7$"

In their Letter, Jean *et al.*[1] attempt to show a "common high-temperature superconducting effect in $La_{1.85}Sr_{0.15}CuO_4$ and $YBa_2Cu_3O_7$." Although this work contains some interesting thoughts, there are also a few criticisms that we feel should be raised. In the interest of brevity, we confine the present discussion to the comparisons made between sintered $La_{1.85}Sr_{0.15}CuO_4$ (produced at the University of Houston) and single-crystal $YBa_2Cu_3O_7$ (grown and characterized at AT&T Bell Laboratories).

Harshman *et al.*[2] first showed that the temperature dependence of the positron annihilation lifetime τ in single-crystal $YBa_2Cu_3O_7$ (only a single lifetime was observed) was markedly different from that observed in the sintered material (usually exhibiting multiple lifetimes). Specifically, $\tau(T)$ for single-crystal $YBa_2Cu_3O_7$ was shown to increase with decreasing temperature below the superconducting transition temperature, T_c, whereas previous (and subsequent) measurements in sintered samples showed $\tau(T)$ to decrease with temperatures below T_c.[3] Interpretation of the single-crystal data suggested that the positron is in a delocalized state, whereas localization (trapping) of positrons was suggested for the sintered samples. More recent studies in sintered $YBa_2Cu_3O_{7-\delta}$ have also indicated strong dependences of the Doppler line shape (S parameter) on Cu—O chain disorder[4] and e^+ implantation depth,[5] emphasizing further the problems encountered with sintered materials.

In Fig. 3 of their paper,[1] Jean *et al.* compare their measurement of $\tau(T)$ in sintered $La_{1.85}Sr_{0.15}CuO_4$ with that observed[2] in single-crystal $YBa_2Cu_3O_7$. This comparison, which indicates a qualitative agreement between the two materials, is then used by Jean *et al.* as the basis for their generalized conclusion of a "common high-temperature superconducting effect." With the consideration of the differences already discussed between sintered and single-crystal $YBa_2Cu_3O_7$, however, there would seem to be little support for the extraction of far-reaching implications by the comparison of the annihilation parameters for a sintered sample of one material with those extracted for a single-crystal sample of another. Indeed, another study[5] of the positron annihilation parameters in sintered $La_{1.85}Sr_{0.15}CuO_4$ has yielded results contradicting those reported by Jean *et al.*[1] Specifically, $S(T)$, as reported in Ref. 5, does not appear to exhibit any distinguishing features at T_c, but instead rises approximately linearly with temperature. Jean *et al.*,[1] on the other hand, report a slope discontinuity in $S(T)$ at $T_c = 33$ K, below which $S(T)$ increases with decreasing temperature.

One also notices that the $\tau(T)$ data for single-crystal $YBa_2Cu_3O_7$ (Ref. 2) are actually incorrectly presented in Fig. 3 of the Jean *et al.* paper.[1] This is because Jean *et al.*[1] make a transformation to reduced temperature (i.e., T/T_c) assuming a superconducting transition (onset) temperature of $T_c = 94$ K. In the original work,[2] however, T_c (onset) of these crystals is shown to be 84 K as measured with dc magnetization (see Fig. 1 of Ref. 2), which is in agreement with recent μ^+ spin-rotation measurements[6] on the same crystals. The group at AT&T Bell Laboratories also made measurements with ac susceptibility which indicated a 95 K onset. However, unlike dc magnetization and μ^+ spin rotation which are both good probes of bulk properties, ac susceptibility is more sensitive to skin effects, resulting (in this case) in a misleadingly high T_c.

To summarize, it is clear that Jean *et al.* arrive at their conclusion largely from the observation that a selected set of data on sintered $La_{1.85}Sr_{0.15}CuO_4$ show a similar trend in the annihilation lifetime as previously observed[2] for single-crystal $YBa_2Cu_3O_7$. Unfortunately, it is equally clear that such an observation is not sufficient in the case of the sintered high-T_c materials.

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