ELSEVIER

Physica C 282–287 (1997) 999–1000

PHYSICA C

ARPES studies of Pb substituted Bi2201 compounds

T. Takeuchi[a,b], H. Ding[a,c], J.C.Campuzano[a,c], T. Yokoya[d], T. Takahashi[d], I. Chong[e], T. Terashima[e], and M. Takano[e]

[a]Materials Science Division, Argonne National Laboratory, Argonne, IL 60439

[b]Department of Crystalline Material Science, Nagoya University, Nagoya 464-01, Japan

[c]Department of Physics, University of Illinois at Chicago, Chicago, IL 60607

[d]Department of Physics, Tohoku University, Sendai 980-77, Japan

[e]Institute for Chemical Research, Kyoto University, Uji, Kyoto 611, Japan

We report angle-resolved photoemission of overdoped $Bi_{1.80}Pb_{0.38}Sr_{2.01}CuO_6$ with different *Tc's* of 4, 8, and 20 K. All samples show similar large Fermi surfaces, centered at (π, π). However, the spectral function linewidth decreases as doping increases. The 4K sample is found to have the typical Fermi liquid linewidth. Comparison is also made to the two layer $Bi_2Sr_2CaCu_2O_8$ compound.

In general, photoemission from the cuprate superconductors shows lineshapes which do not have characteristics of Fermi liquids [1,2,3]. The $Bi_{1.80}Pb_{0.38}Sr_{2.01}CuO_6$ compound (2201) is then very useful, since its low T_c allows us to explore the normal state photoemission spectrum of a cuprate superconductor at low temperatures. This compound does not have a prominent superlattice which complicates the interpretation of data. It allows us to compare the photoemission characteristics to a compound with two CuO_2 layers, $Bi_2Sr_2CaCu_2O_8$ (2212). We carried out high resolution ARPES measurements of overdoped 2201 samples with T_c's of 4, 8 and 20 K. Here we present some preliminary results, and compare them to those from the 2212 compound. From previous work [1] it is known that the peak at E_F at $\overline{M}$ in 2212 originates from states in the CuO_2 planes. This state is a combination of Cu $3d_{x2-y2}$ with O 2p states, and therefore has even symmetry about the $\Gamma - \overline{M}$ direction. We find the same symmetry in 2201. In Fig. 1a we plot the intensity of the peak at $\overline{M}$ as a function of photon polarization, and it can be seen that the peak shows even symmetry, as it does in 2212 [1].

Fig. 1b shows the photon energy dependence of the peak at $\overline{M}$, normalized for monochromator transmission. Similarly to 2212, there is just a smooth variation of the emission intensity with

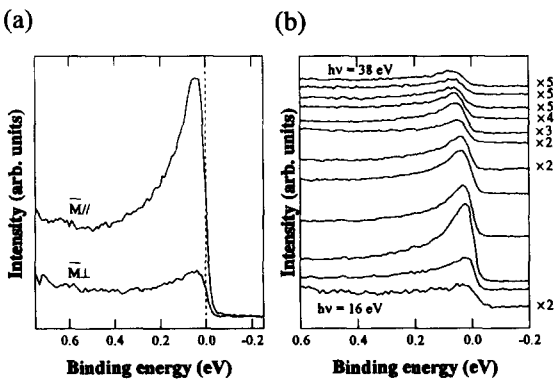

Fig.1: a)Polarozation dependence, and b) photon energy dependence at $\overline{M}$.

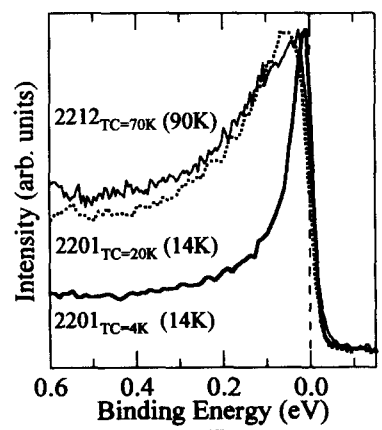

Fig.2: EDC's at $\overline{M}$ for $2201_{TC=4K}$, $2201_{TC=20K}$ and $2212_{TC=70K}$.

PII S0921-4534(97)00572-8

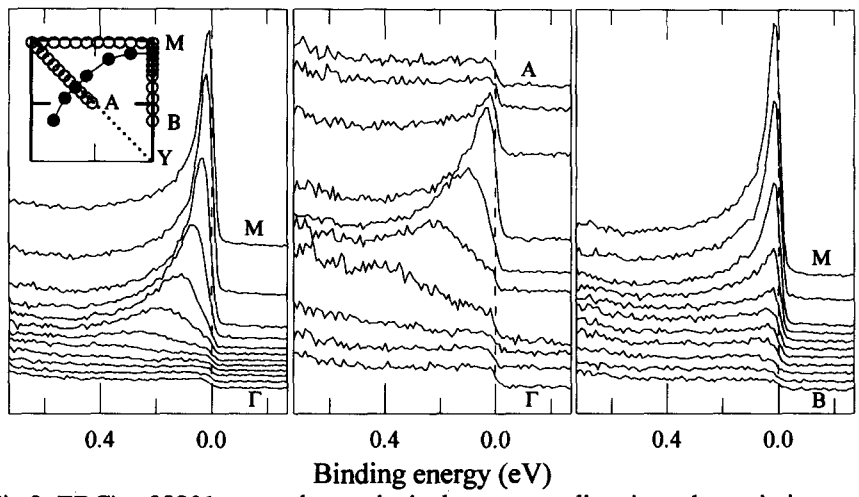

Fig.3: EDC's of $2201_{TC=4K}$ along principal symmetry directions shown in inset.

photon energy, and no obvious z-axis dispersion. Fig. 2 shows high resolution EDC's of the peak at the Fermi energy for the 2201 and 2212 compounds at the $\overline{M}$ point. The overdoped $2212_{TC=70K}$ and the the $2201_{TC=20K}$ samples have similar ratios of their T_c's to optimal T_c ($2212_{TC=92K}$ and $2201_{TC=30K}$, respectively). It can be seen that the spectral functions of these two samples show similar widths, while the highly overdoped $2201_{TC=4K}$ sample exhibits a much sharper peak. In fact, the spectra of $2201_{TC=4K}$ fits well to a simplified spectral function of the form $A(\mathbf{k},\omega) = \Gamma/((\omega-\varepsilon(\mathbf{k}))^2 + \Gamma^2)$, with $\Gamma = const.\times\omega^2$, which is the typical Fermi liquid behavior.

Fig. 3 shows dispersion data for 2201 along the principal symmetry directions. From these we derive the Fermi surface shown in Fig. 4, and compare it to the Fermi surface of the 2212 compound. The Fermi surface topologies are very similar, and in general agreement with previous studies [4-7].

In the dispersion data along the $\Gamma - \overline{M}$ direction, one can see that the spectra continuously build intensity on approaching the Fermi energy. The trailing edge of the spectra seem to all fall on the same line. This clearly violates the spectral function sum rule which states that the spectral weight summed over the entire frequency range must be independent of momentum. Here, the spectral weight keeps building up upon approaching E_F. This effect was noticed by Anderson [8] although in that case the trailing edge had a different scaling.

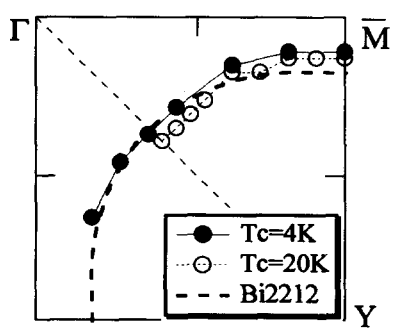

Fig.4: Fermi surfaces of 2201 and 2212.

In conclusion, ARPES spectra of the 2201 compound show similarities to the 2212 compound, such as similar Fermi surface and presence of an extended van Hove singularity below E_F, lack of z-axis dispersion, and non-conservation of spectral weight.

Work supported by DOE contract W-31-109-ENG-38 and NSF grants DMR 9624048, and STCS, under grant No. DMR 91-20000. The Synchrotron Radiation Center is supported by NSF Grant DMR-9212658.

REFERENCES

1. H. Ding, et al., Phys. Rev. Lett. **76**, (1996) 1533.
2. M. Randeria, et al., Phys. Rev. Lett. **74** (1995) 4951.
3. H. Ding, et al., Nature **382** (1996) **51**.
4. D.M. Ratner, et al., Phys. Rev. **B48** (1993) 10482.
5. P. Aebi, et al., Physica C **235-240** (1994) 949.
6. H. Ding, et al., to appear in Phys. Rev. Letters.
7. D.M. King, et al., Phys. Rev. Letters **73** (1994) 3298.
8. P.W. Anderson, in Proc. Materials Res. Soc. V 169, p.3.