Comments

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Comment on "Time-differential perturbed-angular-correlation studies of the amorphous Cu-Hf alloys prepared by mechanical alloying and melt spinning"

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A comparative study of the short-range order in mechanically alloyed and melt-spun HfCu alloys has been presented [Phys. Rev. B **47**, 7732 (1993)]. We comment on the amorphous nature of some of these samples and on some controversial conclusions in that paper.

In their recent publication Kanazawa *et al.*[1] present a time-differential perturbed angular correlation (TDPAC) study of the evolution of short-range order (SRO) around Hf atoms during the mechanical alloying of a mixture of Hf and Cu powders with an average composition $Hf_{43}Cu_{57}$. This process leads to the amorphization of the sample after 60 h of milling. The corresponding TDPAC curve displays the shape characteristic of a broadly distributed quadrupole interaction [upper curve in Figs. 2 and 4(a) of Ref. 1] reflecting the random nature of the probe's environments in that system (random SRO).

Kanazawa *et al.* compare these findings with their own results on a melt-spun alloy of the same composition. The TDPAC spectrum they measured for this system reveals the existence of at least two kinds of sites for Hf probes[1,2] which they call short-range ordered and disordered Hf sites. They conclude that "the melt-spun amorphous alloy tends to exhibit intermetallic compoundlike short-range order." In other words Kanazawa *et al.* claim that both amorphous alloys are different and that the one made by melt spinning exhibits crystallinelike SRO.

We have also studied by the TDPAC technique[3,4] amorphous $Hf_{1-x}Cu_x$ alloys made by melt spinning for $x = 0.33$, 0.44, 0.50, and 0.59. For all the compositions studied and particularly for $Hf_{41}Cu_{59}$ (nearly the same composition studied by Kanazawa *et al.*) we did measure TDPAC spectra which undoubtfully show a broad distribution of quadrupole frequencies without any trace of crystallinelike interactions. The spectra are in fact similar to that found by Kanazawa *et al.* for the mechanically alloyed amorphous sample and are consistent with a random distribution of atoms around the probes.

Therefore the "intermetallic compoundlike short-range order" observed by Kanazawa *et al.* in their quenched sample is not characteristic of the "amorphous state" obtained by this particular method of fabrication but—as we have already pointed out[3]—indicates insufficient amorphization of their alloy. The corresponding spectrum could be interpreted as that produced by a heterogeneous sample with truly amorphous regions and incompletely quenched ones displaying the SRO of crystalline Hf_7Cu_{10}. The very results of Kanazawa *et al.* on mechanically alloyed samples are indeed a confirmation that this system can be obtained in an amorphous state with random SRO when properly prepared.

In conclusion, there is no essential difference in the SRO of quenched and milled HfCu amorphous alloys. In both cases it is consistent with a random distribution of atoms around the probes. Furthermore, the present consensus about amorphous metallic phases is that there are equilibrium (metastable) states which may be accessed depending on the kinetic conditions. Indeed, the possibility of obtaining amorphous alloys by mechanical alloying (at temperatures well below the glass transition) gives support to this description.

[1] I. Kanazawa, T. Oguchi, T. Ohata, K. Tokumitsu, Y. Sakurai, S. Nanao, and T. Iwashita, Phys. Rev. B **47**, 7732 (1993).
[2] Y. Sakurai, I. Kanazawa, Y. Watanabe, S. Nanao, and T. Iwashita, J. Phys. F **16**, L265 (1986).
[3] L.C. Damonte, L. Mendoza-Zélis, and A.R. López García, Phys. Rev. B **39**, 12492 (1989).
[4] L. Mendoza-Zélis, L.C. Damonte, and A.R. López García, Hyperfine Interact. **52**, 161 (1989).

