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Letter

Comment on the paper 'Thermal stability of the $Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ amorphous alloy powder fabricated by mechanical alloying' by Xiu Wei, Xinfu Wang, Fusheng Han, Haowen Xie, Cui'e Wen, J. Alloys Compd. 496 (2010) 313–316

K.G. Prashanth *

(FI-1) Institute of Applied Materials, Helmholtz Zentrum Berlin für Materialien und Energie, Glienickerstr. 100, D-14109 Berlin, Germany

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ABSTRACT

Wei et al. recently reported about the thermal stability of $Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ amorphous alloy powder fabricated by mechanical alloying. The phrase 'amorphous alloy powder' is claimed from the XRD and TEM results. However, the XRD pattern of 120 h milled powder shows a small crystalline peak at $2\theta \sim 38^\circ$, which has not been addressed. This unaddressed peak belongs to the intermetallic Al_3Ni phase which is still present after 120 h of mechanical alloying. Also the TEM results support the presence of crystalline/nano-crystalline phase(s), which the authors have not addressed. Hence the powder is nearly amorphous and not completely amorphous as interpreted by Wei et al.

1. Comment

Wei et al. have recently reported a publication on 'Thermal stability of the $Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ amorphous alloy powder fabricated by mechanical alloying' in Journal of Alloys and Compounds, volume: 496, year: 2010, pages: 313–316. It describes the production of so called amorphous powder by mechanical alloying followed by some kinetic studies. However, the present author feels there is room for discrepancies and would like to discuss further on them.

Wei et al. have claimed the following:

(1) The XRD patterns of $Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ powders milled for different times are shown in Fig. 1. The 20 h milled powder has several sharp peaks corresponding to pure elements (Al, Ti, Ta and Zr), and other peaks related to intermetallic phases such as AlNi and Al_3Ni. These peaks gradually became lower in intensity and broader and some peaks even disappeared as the milling time increased. With further increase in the milling time, for example 80 h, a broad halo peak appeared in the range of diffraction angle, 2θ, from 30° to 50°, which indicates the formation of an amorphous phase. After milling for 120 h, all the diffraction peaks typical of crystalline phases disappeared, indicating the completion of the vitrification process.
(2) Fig. 2 shows the TEM bright-field image with selected are diffraction pattern of the 120 h milled powder. It can be seen that the particles show a very fine and homogeneous microstructure, and there is a diffusive halo typical of an amorphous phase, being in agreement with the XRD results shown in Fig. 1.

For better understanding, Figs. 1 and 2 mentioned by Wei et al. have been taken from Wei et al. paper and is also shown here with suitable modification. Wei et al. have claimed from the XRD pattern after 120 h of milling, that all the diffraction peaks typical of crystalline phases have disappeared, indicating the completion of the vitrification process. After careful analysis of the XRD pattern (120 h milled powder), the presence of crystalline peak at $2\theta \sim 38^\circ$ of lower intensity is realized. When the 120 h XRD pattern is compared with the XRD patterns of, say 60 h, 80 h and 100 h milled powder, it suggests the small crystalline peak should correspond to the intermetallic Al_3Ni phase (space group: *Pnma*). Also, there might be the presence of a peak from Zr-phase (may be in nano-crystalline form) at $2\theta \sim 32.5^\circ$, but still the presence is questionable from the XRD pattern alone.

Prashanth et al. [2] shows the presence of α-Al and the intermetallic Al_2Y phase after 200 h mechanical alloying of $Al_{70}Y_{16}Ni_{10}Co_4$ powders. Surreddi et al. [3] has similar results, where the presence of α-Al and the intermetallic $Al_{19}Gd_3Ni_5$ has been observed in a gas atomized $Al_{84}Gd_6Ni_7Co_3$. Both the compositions $Al_{70}Y_{16}Ni_{10}Co_4$ and $Al_{84}Gd_6Ni_7Co_3$ belong to the same family of $Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ (Al-RE-TM). Similar results with the presence of α-Al and/or an intermetallic phase for mechanically alloyed as well as gas atomized Al-based powders can be found elsewhere but

* Corresponding author. Tel.: +49 30 8062 3240; fax: +49 30 8062 3059.
E-mail address: kgprashanth@gmail.com.

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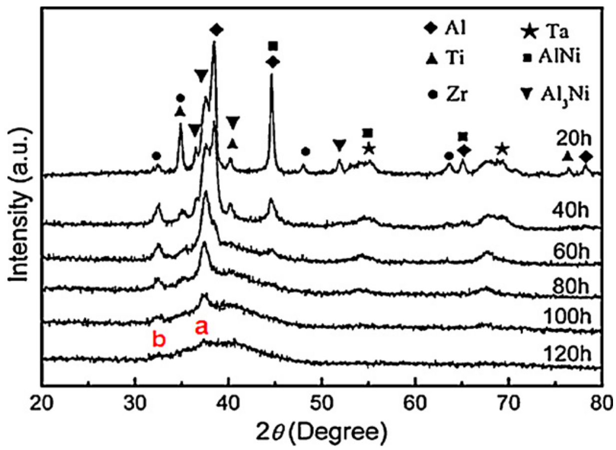

Fig. 1. XRD patterns (Co-K_α radiation) of mechanically alloyed $Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ powders milled for different times where a – Al_3Ni, b – Zr-phase (presence is highly questionable) (taken from X. Wei, et al., J. Alloys Compd. 496 (2010) 313–316 and is modified suitably).

in [4]. Literatures suggest that, it is very difficult for an Al-based powder to vitrify completely [2–5]. In most of the cases, the intermetallic phases never disappear completely and in some cases, the presence of α-Al is also observed [2–5]. Hence the statement 'completion of the vitrification process' claimed by Wei et al. is highly questionable.

From the TEM pattern (Fig. 2) Wei et al. have claimed the presence of diffusive halo typical of an amorphous phase, from which they confirm the 120 h mechanically alloyed $Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ powder as an amorphous alloy. The TEM result does show the presence of diffusive halo but also have some other patterns which are marked as 1 and 2. The patterns marked as 1 and 2 do not belong to the amorphous phase and suggest the presence of nanocrystalline/crystalline phase(s). The present author cannot analyze the patterns present in Fig. 2 thoroughly enough to find out the phases related to them, since the technical data behind this pattern is missing from Wei et al. Hence the 120 h mechanically milled $Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ alloy can be defined as a nearly amorphous alloy and is not completely amorphous as believed by Wei et al. It is recommended that the authors of Ref. [1] once again analyze the XRD as well as the TEM patterns thoroughly and find out the crystalline phases present in these patterns apart from the amorphous phase.

As the author of the present comment has been strongly concerned with the term '$Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ amorphous alloy powder', he is pleased to provide the information about the phases present after 120 h mechanical alloying of $Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ powder for a better understanding to prove that $Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ powder is a nearly amorphous powder.

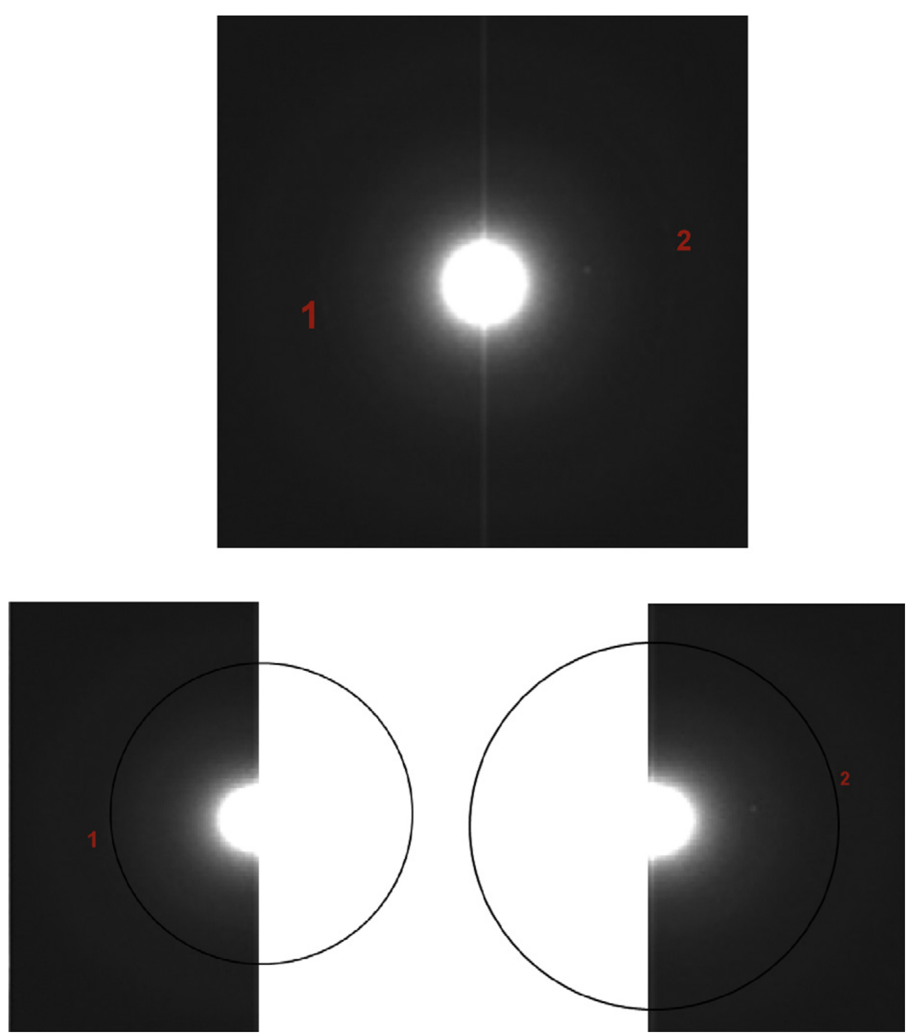

Fig. 2. TEM diffraction pattern of $Al_{70}Ni_{10}Ti_{10}Zr_5Ta_5$ powders milled for 120 h (taken from X. Wei, et al., J. Alloys Compd. 496 (2010) 313–316 and is adjusted for contract and brightness for better readability).

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