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Crystallization kinetics of Cu-Zr-Al amorphous alloys

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Abstract: In this study the crystallization of the $Cu_{42}Zr_{44}Al_{14}$, $Cu_{48}Zr_{43}Al_9$ and $Cu_{53,5}Zr_{42}Al_{4,5}$ were investigated by DSC measurements using simultaneously fitting of three DSC scans realized in different conditions, isothermal conditions, and at different heating rates (5, 10 and 20 K/min), which were all combined in a single calculation. The relevant parameters associated with different kinetic models were calculated and their ability to predict the crystallization evolution in isothermal treatments was evaluated.

Kinetic parameters related to crystallization of metallic alloys usually are carried out by adopting some kinetic model-free procedures like those proposed by Kissinger, Ozawa-Flynn-Wall among others. Although these parameters can offer some insight about the thermal crystallization reaction, they are just apparent values and really no kinetic information can be achieved in order to predict the crystallization evolution. Another frequently used approach is the direct fit [1,2] of a kinetic model in a single DSC scan, but in this case the proper kinetic model must be known or determined before studying the transformation kinetics, which is not so easy for some BMG's alloys that nanocrystallizes during thermal crystallization. The precise knowledge of the kinetic model for this approach is of crucial importance, once a wrong kinetic model can be well fitted to the DSC curve, due to the high correlation that exist among the kinetic parameters, which is known as kinetic compensation effect. In this study the crystallization of the $Cu_{42}Zr_{44}Al_{14}$, $Cu_{48}Zr_{43}Al_9$ and $Cu_{53,5}Zr_{42}Al_{4,5}$ were investigated by DSC measurements using simultaneously fitting of three DSC scans realized in different conditions and at different heating rates (5, 10 and 20 K/min), and also in isothermal conditions which were all combined in a single calculation. This procedure minimizes the kinetic compensation effect and involves the whole field of reaction. The alloys have been chosen in function of distinct glass forming ability according to the topological instability λ criterion [2]. The relevant parameters associated with different kinetic models were calculated and their ability to predict the crystallization evolution in isothermal treatments were evaluated.

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