2010 Spring **06. 01. 2010**

"Amorphous Materials"

Class # Name

1. (a) Fill in the blank. (7 points)

In general, higher GFA can be achieved by increasing the stability of liquid phase, which can be reflected by the amount of melting temperature ( ). To estimate the relative ( ) of the liquid phase, the dimensionless melting temperature depression parameter ( ) has been introduced. The parameter represents a fractional depression of liquidus temperature from the calculated melting temperature, T_m^{mix}. Liquid phase with a ( ) composition exhibits large melting temperature depression and high relative stability in the given alloy system.

Egami and Waseda have suggested the following criterion for the formation of the amorphous phase in binary alloy systems based on the atomic scale elasticity theory:

$$x_B^{\min}\left|\frac{(v_B - v_A)}{v_A}\right| = x_B^{\min}\left|(\frac{r_B}{r_A})^3 - 1\right| \approx 0.1 \qquad \textbf{(1)}$$

, where $x_B^{\min}$ is the minimum solute content, and v_i and r_i (*i* = A, B) are atomic volume and atomic radius, respectively. Above a certain level of ( ), the crystalline solid solution loses its stability and glass can form. The larger the atomic size difference, the smaller the amount of solute is required to form an amorphous phase. However, the criterion estimates only ( ) solute content for the formation of amorphous phase. Based on the criteria shown in equation (1), it is expected that GFA increase with increasing the overall atomic size mismatch unless the competing crystalline phase against the formation of amorphous phase does not ( ). Therefore, the extent of atomic mismatch can be considered as one of the parameters reflecting the GFA of BMGs. Based on the equation (1), the overall effect of atomic size mismatch on GFA can be extended to ternary alloys by the following P parameter:

$$P = x_B\left|\frac{(v_B - v_A)}{v_A}\right| + x_C\left|\frac{(v_C - v_A)}{v_A}\right| \qquad \textbf{(2)}$$

The parameter *P* represents the effects of atomic mismatch depending on the relative amount of ( ) atoms. The global effect of atomic mismatch in equation (2) can be ( ) with total amount of solute as follow:

$$P' = \frac{x_B}{x_B + x_C}\left|\frac{(v_B - v_A)}{v_A}\right| + \frac{x_C}{x_B + x_C}\left|\frac{(v_C - v_A)}{v_A}\right| \qquad \textbf{(3)}$$

, i.e. *P'* =( ) *P*. The P' parameter represents the ( ) atomic mismatch of each solute atom, which is dependent on alloy system and composition. As discussed above, ΔT^* parameter can be considered as a measure for stabilization of liquid by solute atoms, and P' parameter can be considered as a measure for effective atomic mismatch of solute atoms. When considering the effect of ΔT^*, a liquid alloy with deep eutectic composition is most favorable for high GFA. However, increase of atomic mismatch can further destabilize the ( ) crystalline phase against glass formation. Therefore, the alloy composition having high ( ) may shift from the deep eutectic composition toward the compositions having larger ( ) parameter. If the GFA is considered from the perspectives of thermodynamic stability of liquid, ( ) and atomic configuration of liquid phase, ( ), a parameter for GFA can be expressed by combining two parameters as follows:

σ= ( ) .

(b) Draw and briefly explain the schematic diagram showing physical meaning of sigma parameter. (3 points)

*** Suggestion for class or request for personal conversation:**

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