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Producing of Amorphous-Nanocrystalline Composite Powders

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Abstract : CuZrAl amorphous alloys have attracted high interest due to unique physical and mechanical properties, which can be enhanced by adding of Ni and Ti elements. It is known that this properties can be enhanced by crystallization of amorphous alloys creating nanocrystallines in the matrix. The present work intends to produce nanosized crystalline parti-cle reinforced amorphous matrix composite powders by crystallization of amorphous powders. As the first step the amorphous powders were synthe-tized by ball-milling of crystalline powders. (Cu49Zr45Al6) 80Ni10Ti10 and (Cu49Zr44Al7) 80Ni10Ti10 (at%) alloys were ball-milled for 12 hours in order to reach the fully amorphous structure. The impact en-ergy of the balls during milling causes the change of the structure in the powders. Scanning electron microscopical (SEM) images shows that the phases mixed first and then changed into a fully amorphous matrix. Furthermore, nanosized particles in the amorphous matrix were crystallized by heat treatment of the amorphous powders that was confirmed by TEM measurement. It was of importance to define the tem-perature when the amorphous phase starts to crystal-lize. Amorphous alloys have a special heating curve and characteristic temperatures, which can be meas-ured by differential scanning calorimetry (DSC). A typical DSC curve of an amorphous alloy exhibits an endothermic event characteristic of the equilibrium glass transition (Tg) and a distinct undercooled liquid region, followed by one or two exothermic events corresponding to crystallization processes (Tp). After measuring the DSC traces of the amorphous powders, the annealing temperatures should be determined between Tx and Tp. In our experiments several temperatures from the annealing temperature range were selected and de-pendency of crystallized nanoparticles fraction on their hardness was investigated.

Keywords : amorphous structure, composite, mechanical milling, powder, scanning electron microscopy (SEM), differential scanning calorimetry (DSC), transmission electronmocroscopy (TEM)
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