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On Conditions of Bulk and Surface Glass Formation of Metallic Alloys

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Highlights

Favorable glass formation is considered as eutectic interaction of glass forming compounds

Best glass formation is achieved at quenching from UnderCoolable Melt range

Heat dissipation at electro-spark deposition is comparable with melt spinning

Abstract

This work is done to analyze the effect of glass forming compounds and melt processing on bulk and surface glass formation. Key factors of glass formation of metallic alloys including structure-phase state of solid precursor (i.e. master-ingot, spun ribbon, powder, etc.) and its melt, conditions of cooling melt and its ability for deep undercooling are considered. A ratio of crystalline glass forming compounds in annealed best BMG compositions is considered to develop a strategy of searching new alloys. Surface glass formation at electro-spark deposition of precursors with high and low GFA used as consumable electrodes is studied. It found that surface glass formation is possible due to both weak and strong chemical interaction of an electrode and a substrate. The former is due to mass transfer of high glass forming ability (GFA) precursor onto metallic substrate with local "drop-by-drop" anode melting stimulated by electric discharge and needs no chemical interaction. The latter goes with diffusion interaction between low GFA precursor and a metallic substrate by a local melting and it is other way to form amorphous surface layer. In both cases the solidification rate of molten drops by electro-spark deposition is enough to suppress crystallization and is compared to melt spinning.

Keywords: metallic glasses, composite materials, liquid-solid reactions, rapid-solidification, quenching, crystal structure, thermal analysis

1 Introduction

Glass Formation seems a "magic" feature of metallic melts. It manifests itself as the interaction of both thermodynamics and kinetics factors of solidification, which is controlled by intrinsic properties of the alloy as well as by the conditions of the technology of melt quenching. There were many efforts [1-5] to rationalize the feature factors of glass formation and determine the composition of bulk metallic glass (BMG) forming alloys based on Zr, Cu, Fe, etc. However, only limited industrial applications of the BMGs are known [6, 7].