

Editorial

Experimental and Theoretical Advances in Amorphous Alloys

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Unlike crystalline alloys having long-range order in atomic arrangements, amorphous alloys are disordered solids [1–4]. Yet their structure when solidified is not completely disordered but contains short- to medium-range ordered clusters [5, 6]. This unique structure endows them with superior mechanical, physical, and chemical properties. Therefore, amorphous alloys are of both scientific and technological interests. Recent progress in experimental and computational techniques has greatly advanced our understanding of a number of key issues such as glass structure at atomic level, glass-forming ability (GFA), and structure-property relationship in this field [7, 8]. In spite of this, ongoing research efforts remain necessary to uncover the atomic-level mechanisms underlying the glass formation and the deformation, as well as the glass structure.

Bulk amorphous alloys (BAAs) with diameters of more than one centimeter are preferred for practical engineering applications. To develop such alloy systems with extremely high GFA, several strategies, including large undercooling (LU), Inoue's three empirical rules (ITER), and flux treatment, have been proposed [2, 9–11]. Among them, minor alloying additions (MAA) and fluxing prove to be significantly beneficial for enhancing GFA and thus enabling the formation of centimeter-scale BAAs [12–14]. As listed in Table 1, a combination of these strategies could be employed for producing centimeter-scale BAAs.

In addition to glass formation, the mechanical property of amorphous alloys is also one of the hot topics in this field. Although shear localization is responsible for their catastrophic failure, there is a need for a better understanding of initiation, development, and percolation of these shear

transformation events. At atomic level, shear transformation zones (STZs) are supposed to be activated in response to external stimuli and eventually develop into shear bands during deformation. Unfortunately, these clusters are very small with an average size of ~1 nm and appear only at a very early stage of deformation, which makes it very difficult to be observed experimentally. On the other hand, both structural disordering and the formation of nanocrystals have been evidenced inside shear bands after deformation [15], implying that atomic rearrangements must occur. Moreover, the nanocrystal size and their distributions could be related to shear transformations, particularly when the energy barrier to crystallize is comparable to or even smaller than that to activate percolated STZs globally. As a consequence of deformation, structural evolution inside shear bands could help uncover the underlying deformation mechanisms for amorphous alloys.

Last but not least, dealloying amorphous alloys has raised tremendous attentions by producing highly active nanoporous metals used for catalysts and electric devices such as solar cells, sensors, or some other electric components. This provides a convenient way to design novel nanostructured materials with desirable functionalities.

In summary, this special issue is mainly focused on the development of bulk amorphous alloy, mechanical response, and new functionalities explored in amorphous alloys. We hope that the readers will find in this special issue not only interesting experimental results on the formation of centimeter-scale BAAs induced by fluxing or minor alloy additions and new functional nanoporous metals by dealloying amorphous alloys and amorphous alloy composites

TABLE 1: The strategies for producing centimeter-scale amorphous alloys.

Representative BAAs	Critical size for glass formation (mm)	LU	ITER	Fluxing	MAA
Pd-Ni-Cu-P [16]	80	√	√	√	√
Zr-Ti-Cu-Ni-Be [17]	50	√	√		
Cu-Zr-Al-Ag [16]	30	√	√		
Fe-Cr-Co-Mo-Mn-C-B-Y [18]	12	√	√		√

combining with high strength and large ductility but also theoretical advances in the underlying deformation mechanisms at atomic scale.

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