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# Editorial: Nanostructured Glass: Properties and Applications

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## Editorial on the Research Topic

## Nanostructured Glass: Properties and Applications

Nanotechnology is playing an important role in both fundamental science and advanced technology. It remains an interesting topic for researchers in different fields. However, most of the materials in use are in crystalline form. When the grain size of the bulk crystalline materials down to the nanometer range (<100 nm), they show interesting properties compared to the bulk of the same chemical compositions. The grain boundaries of the crystalline materials have different atomic arrangements compared to the grain regions. The nano-crystalline materials contain a high volume of grain boundaries due to the nanometer-sized grains. Hence, nano-crystalline materials demonstrated exciting properties by adjusting grain boundaries' density and controlling the grains' size down to the nanometer. Another most popular material, i.e., glass has been extensively used since civilization; apart from crystalline materials. Glass has unique structural features compared to crystalline materials. It has a disordered atomic structure and is thermodynamically unstable (has a non-equilibrium, or metastable state). It does not have any distinct microstructure like the crystalline materials. However, several advancements have been materialized recently to understand the structure and thermodynamics of the glass at the nanoscale. Though, understanding the structure and properties of the nanostructured glassy materials is at a preliminary stage. It would be the next generation revolution in nanotechnology if substantial research on the nanostructure of glassy materials can be encouraged.

Recently, an exciting concept of nanoglass is developed similar to nano-crystalline materials. These nanoglass has been synthesized by the compaction of nanosized glassy particles and glass-glass interfaces created between the glassy nanoparticles. It is evidenced that nanoglass consist of a nanometer-sized glassy core (5–20 nm) and an interface (1–5 nm). Interestingly, there are different atomic arrangements between the core and the interface regions of the nanoglass. This unique microstructure feature of nanoglass leads to exciting properties that are not present in the conventional glasses of the same chemical compositions. There is an evolving glass research interest in improving the properties and functions through modification of its nanostructure. It has been reported that the nanostructured glassy materials show enhanced mechanical and magnetic properties compared to the bulk glasses.

In this collection of articles, three contributions from different authors have been published. In the first published work (Sharma et al.), authors have reported the deformation character of as-prepared and structurally relaxed Cu-Zr based nanoglasses are explored by nano- and micro-indentation experiments. The as-prepared nanoglass are structurally relaxed by annealing them near the glass transition temperature ($T_g$) without changing its amorphous nature. It was found that the indentation load against displacement curves of structurally relaxed samples revealed distinct

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displacement bursts. However, as prepared nanoglass sample did not show such features. This observation suggests that annealing has affected the localized amorphous structure. Moreover, they observed the shear bands in the structurally relaxed nanoglass subjected to the micro-indentation test, but these shear bands were absent in the case of as-prepared nanoglass. In the second publication (Adjaoud and Albe), the authors have investigated the effects of segregation and structural relaxation on the mechanical properties of $Cu_{64}Zr_{36}$ nanoglass through nanoindentation using molecular dynamics simulation. The load-displacement curves analysis reveals that the elastic modulus of nanoglasses is lesser than that of a homogeneous metallic glass of the same composition. They found the defective short-range order of atomic structure at the glass-glass interface of the nanoglass. The structural relaxation achieved by long-time annealing at 0.8 $T_g$ that resulted a shift from a homogeneous deformation to a combination of shear bands and homogeneous deformation. The last report is based on the metallic nanoglass and nanocrystallization reactions in metallic glass systems (Perepezko et al.). In this article, it is fascinating to see the modification in the properties of metallic glass by monitoring the crystallization process and the glass transition behaviour. They summarized some recent works to alter the properties of metallic glasses without varying the composition. The reports from different works on metallic nanoglass stipulated the microstructure feature of nanoglass. It can increase glass stability and suggest an alternative mechanism for producing ultrastable glass.

In conclusion, all the above three contributions from different authors can stimulate further research on nanostructured glassy materials. We hope the current research topic will encourage the next generation revolution to lead the glass-based nanotechnology. Moreover, this initiative is relevant to celebrating the International Year of Glass 2022, declared by the general assembly of the United Nations.

## AUTHOR CONTRIBUTIONS

SS has prepared the original draft. ML and HF have revised the draft.

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