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Plasticity improvement of Zr-based Bulk Metallic Glasses (BMGs) by laser treatment

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Laser shock peening (LSP), as a modern surface processing technique, can improve the plasticity and increase the strength of BMGs by introducing residual stresses and fine multiple shear bands into their surface. The improvement of both plasticity and strength following laser treatments was confirmed through the compression experiments on Zr-based BMG Vit-105 ($Zr_{52.5}Cu_{17.9}Ni_{14.6}Al_{10.0}Ti_{5.0}$ in atomic percent, at. %) in this study. To depict the laser effect, a focused-ion-beam (FIB)-based micro-slot cutting (μSC) method was employed to map the residual-stress distribution. Meanwhile, a finite element model of LSP was developed to predict the residual-stress distribution using the ABAQUS software, which is comparable with experimental measurements. As a powerful characterization technique, atom probe tomography will be used to probe the existence of nanocrystals induced by laser treatments, and to elucidate the microstructure of the laser-affected layer. Furthermore, a new theory for the statistics of slip avalanches is being developed for the analysis of plastic deformation following laser treatments, expected to unveil the mechanism of plasticity improvement.

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