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Abstract

Surface engineering of ZrCuAl-based bulk metallic glasses (BMGs) by sub-T_g gaseous oxidizing is hypothesized an effective means to introduce compressive residual stresses in the surface region of these inherently brittle materials and thereby postpone crack initiation. Various BMGs were oxidized in gas mixtures with different oxygen partial pressures. It was demonstrated that appreciable surface hardening is achieved by the development of nano-crystalline ZrO_2 in the oxygen-enriched zone (the hardened case), reaching hardness values of up to 1200 HV [1]. X-ray diffraction and focused ion-beam ring-core digital image correlation (FIB-DIC) demonstrate that indeed compressive residual stresses developed in the hardened case. Furthermore, a surprising self-repair effect was observed when surface cracks appeared [2-3]. The mechanism of self-repair appears to be (compressive) stress-induced diffusion of noble elements to crack surfaces (as well as the BMG surface), where they segregate as crystalline metals and effectively close the crack.

1. S. Haratian, et al. J. All. Comp. 800 (2019) 456-461.
2. S. Haratian, et al. Scripta Mater. 164 (2019) 126–129.
3. S. Haratian, et al. Acta Mater. 200 (2020) 674–685.