Ideal clinical biomaterials have to satisfy the following conditions: good biocompatibility, non-toxicity, non-allergic responses, non-carcinogenic effects, and applicable mechanical properties. Because of the outstanding corrosion resistance, high wear resistance, good biocompatibility and low Young’s modulus, bulk metallic glasses (BMGs) have attracted interests and make them potential candidates for bio-implants. Recently, some studies pointed out that some different corrosion behaviors for metallic glasses with different degrees of partial crystallization. But it is still not certain whether the metallic glass alloys in fully amorphous or partially nanocrystalline state would exhibit better bio-corrosion behavior. In this study, we examine this effect in the Zr- and TiZr-based amorphous alloys in simulated body fluid (SBF).

Simulated Body Fluid Electrochemical Response of Zr- and TiZr-based Metallic Glasses with Different Degrees of Crystallization

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Abstract

Zr-based metallic glasses with different crystallinities

Figure 1 (a) DSC curves and (b) XRD patterns of as-cast Zr_{55}Cu_{30}Ni_{9}Al_{8} metallic glasses and its partial crystalline alloys.

Figure 2 (a) Potential polarization curves and (b) Nyquist plots of the as-cast and annealed Zr_{55}Cu_{30}Ni_{9}Al_{8} metallic glasses in the Hank’s solution.

Possible models of passive layer

Non-protective passive layer

Zr_{55}Cu_{30} and Zr_{55}Ni nanocrystals

Amorphous matrix

Protective passive layer

Amorphous matrix β-Ti nanocrystals

Conclusions

In ZrCuNiAl MG, the nanocrystals with noble elements (such as Cu or Ni in this case) in the amorphous matrix will form non-protective passive layer and produce serious galvanic corrosion, which would reduce their corrosion resistance. But in TiZrSiTa MG, without any Cu, the nanocrystallized Ti_{42}Zr_{42}Si_{15}Ta_{3} MG own highest $E_{\text{corr}}$, due to the formation of denser passive layer.