



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

C. H. Huang\*, C. H. Hsieh, and J. C. Huang

Department of Materials and Optoelectronic Science, National Sun Yat-Sen University, Kaohsiung 804, Taiwan ROC

\* Corresponding and presenting author. Tel.: +886-7-5254070; fax: +886-7-5254099.

E-mail address: [andygromacs@gmail.com](mailto:andygromacs@gmail.com) (C. H. Huang)

## Abstract

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 the different corrosion behavior for metallic glasses with different degrees of partial crystallization. In this study, we examine this effect in the  $Zr_{53}Cu_{30}Ni_9Al_8$  amorphous melt spun ribbons in simulated body fluid (SBF). This work would give better systematic understanding of electrochemical responses of the amorphous and nanocrystalline  $Zr_{53}Cu_{30}Ni_9Al_8$  alloys with different degrees of crystallization in SBF and would establish the clear profile of their corrosion behavior.

## Results and discussion

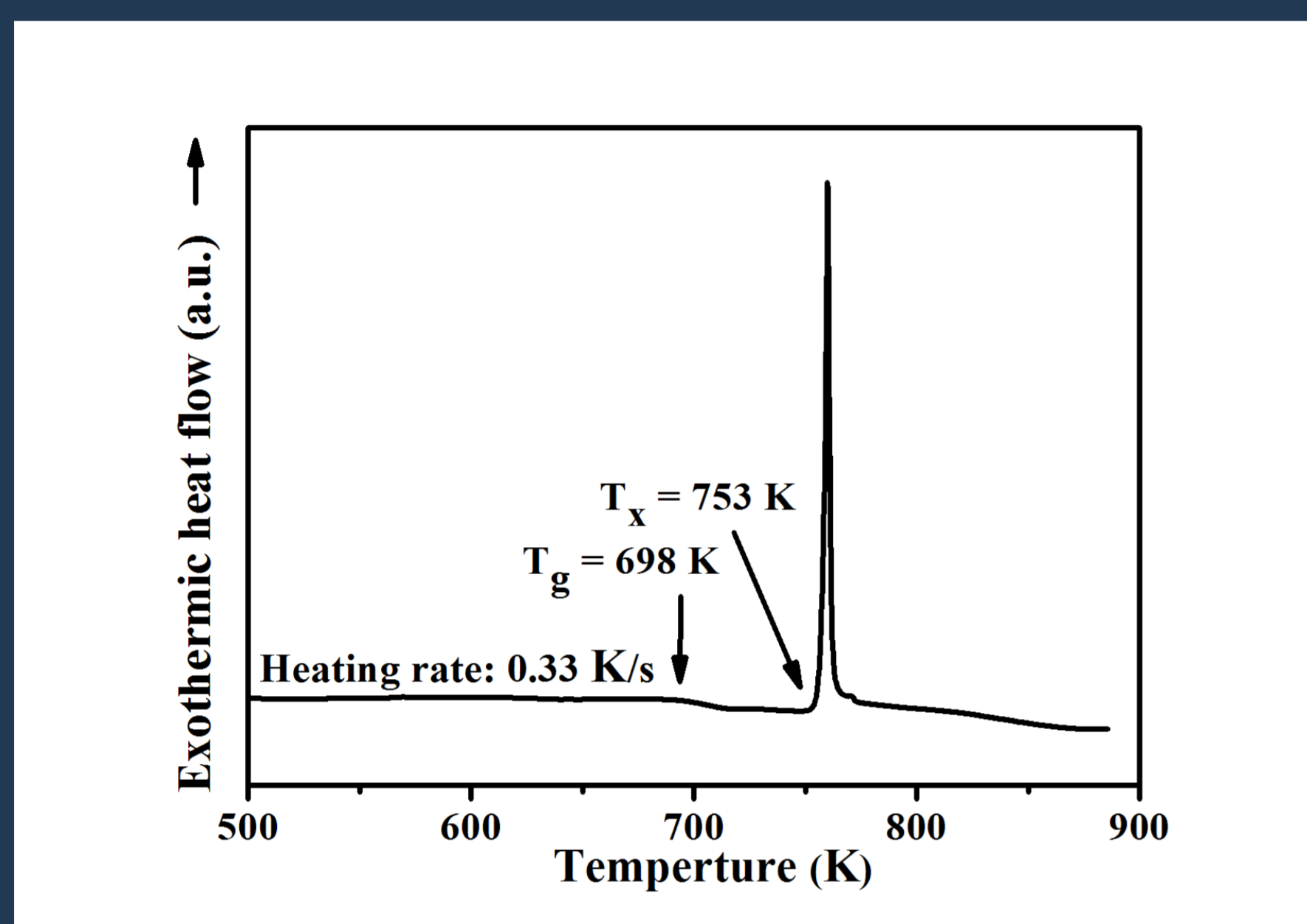


Figure 1 DSC curve of as-fabricated  $Zr_{53}Cu_{30}Ni_9Al_8$  metallic glasses.

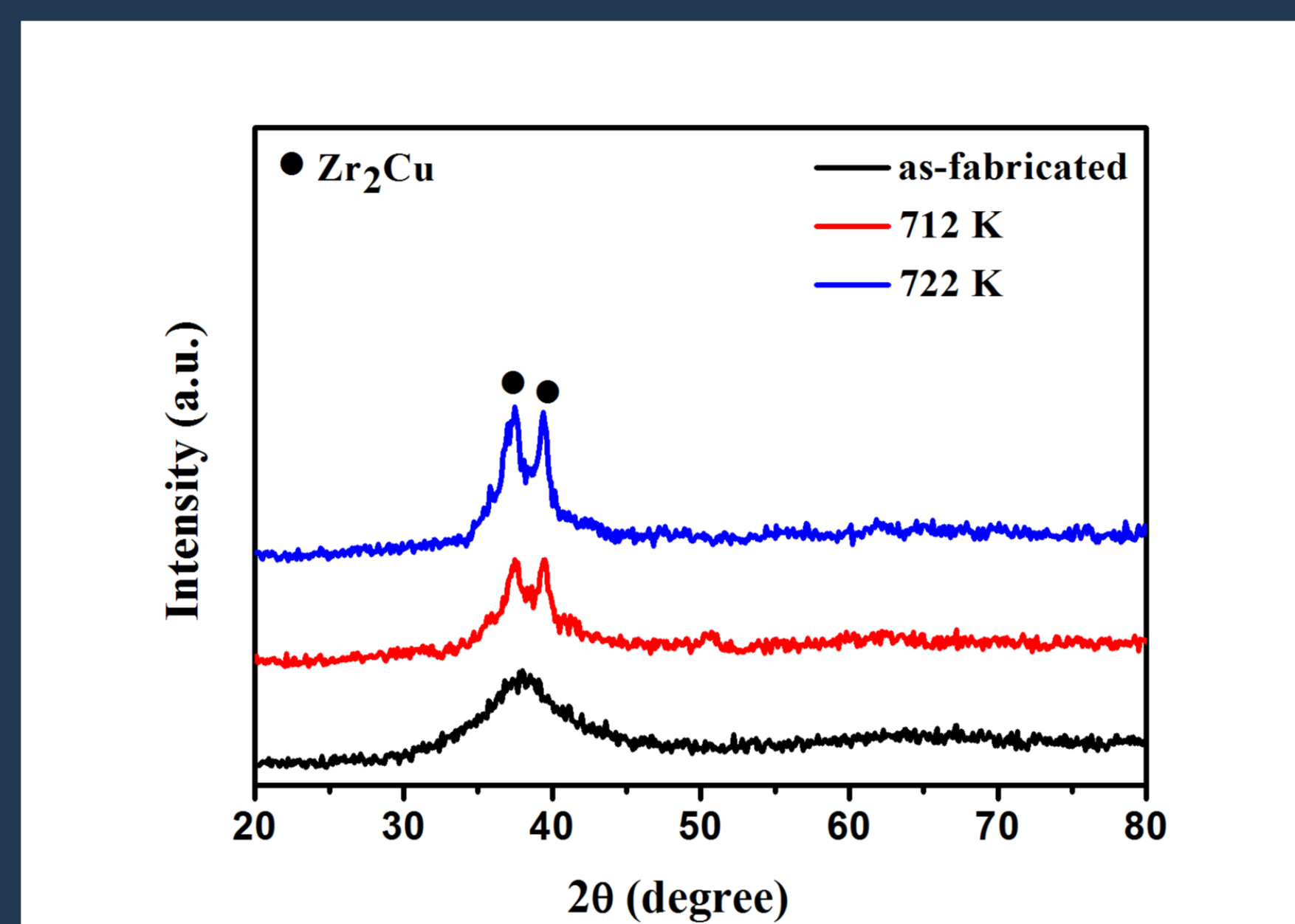


Figure 2 XRD patterns of as-fabricated  $Zr_{53}Cu_{30}Ni_9Al_8$  metallic glasses and its partial crystalline alloys.

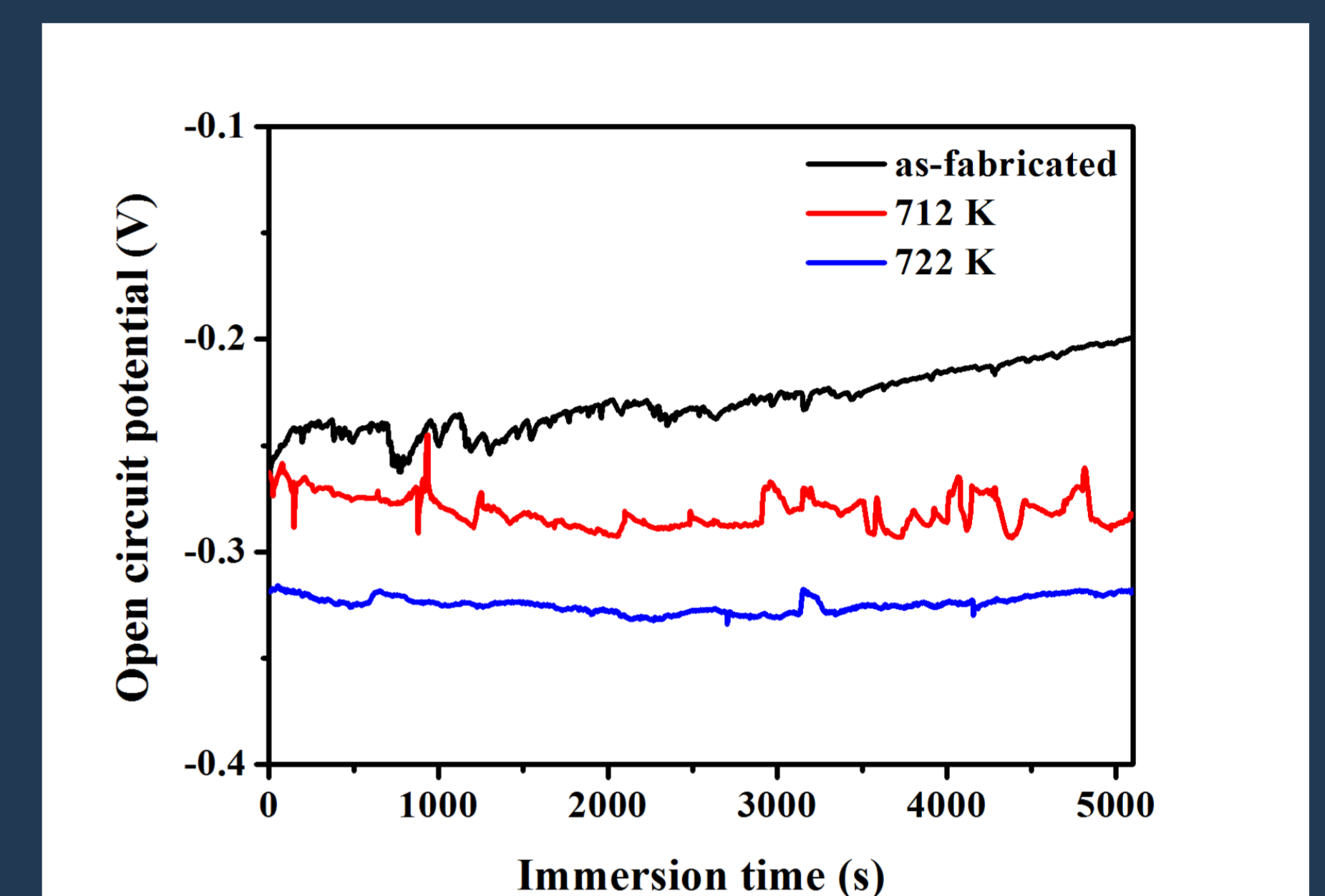


Figure 3 Open circuit potential of as-fabricated  $Zr_{53}Cu_{30}Ni_9Al_8$  metallic glasses and its partial crystalline alloy.

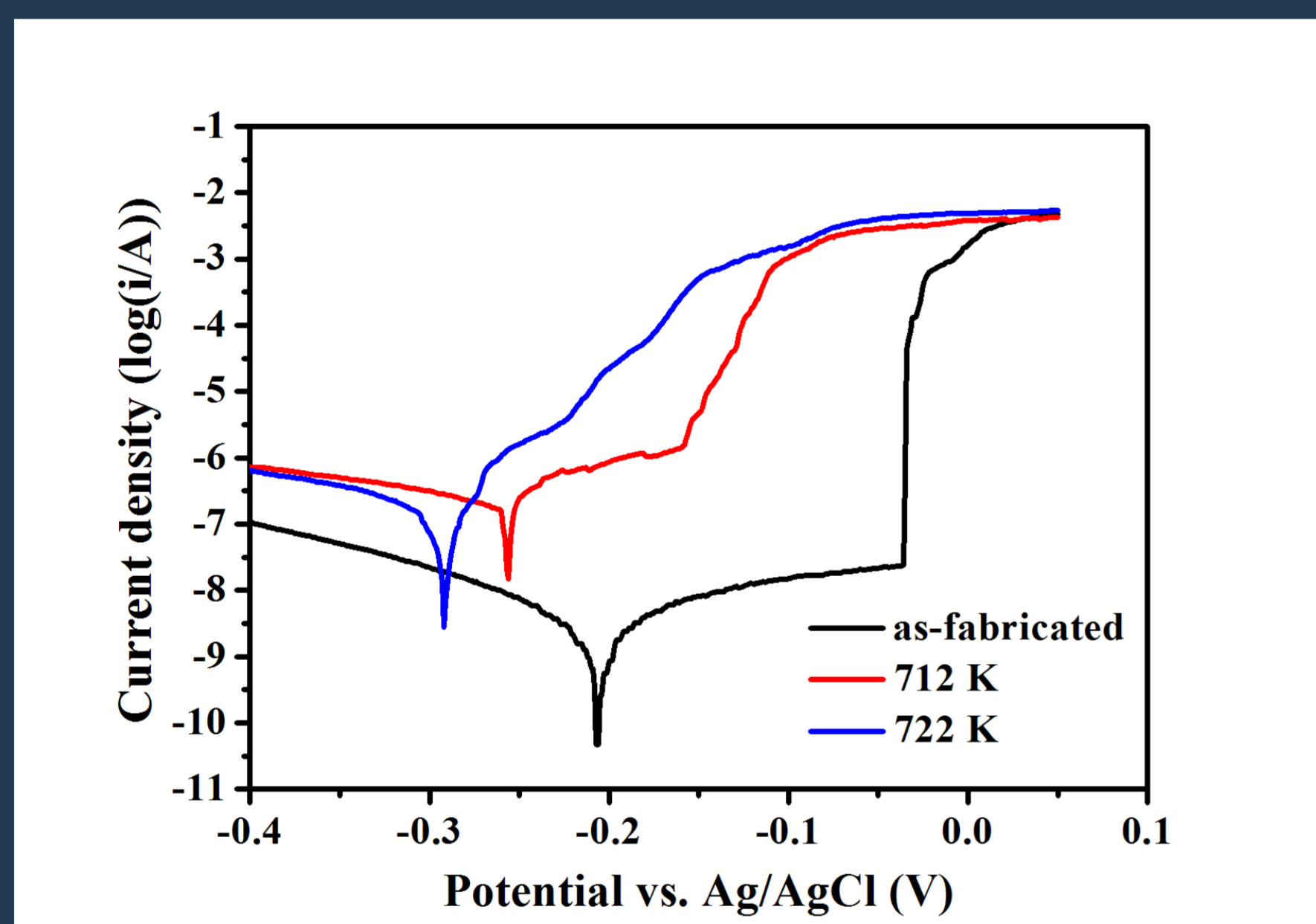


Figure 4 Potential polarization curves of as-fabricated  $Zr_{53}Cu_{30}Ni_9Al_8$  metallic glasses and its partial crystalline alloys at 310 K in Hank's solution.

	$I_{corr}$ (i/A)	$E_{corr}$ (V)	$E_{pit}$ (V)	$E_{pit}-E_{corr}$ (V)
As-fabricated	$6.691 \times 10^{-9}$	-0.207	-0.037	0.170
712 K	$7.132 \times 10^{-7}$	-0.256	-0.159	0.097
722 K	$1.627 \times 10^{-7}$	-0.292	-0.228	0.064

Table I Corrosion properties of as-fabricated  $Zr_{53}Cu_{30}Ni_9Al_8$  metallic glasses and its partial crystalline alloys at 310 K in Hank's solution

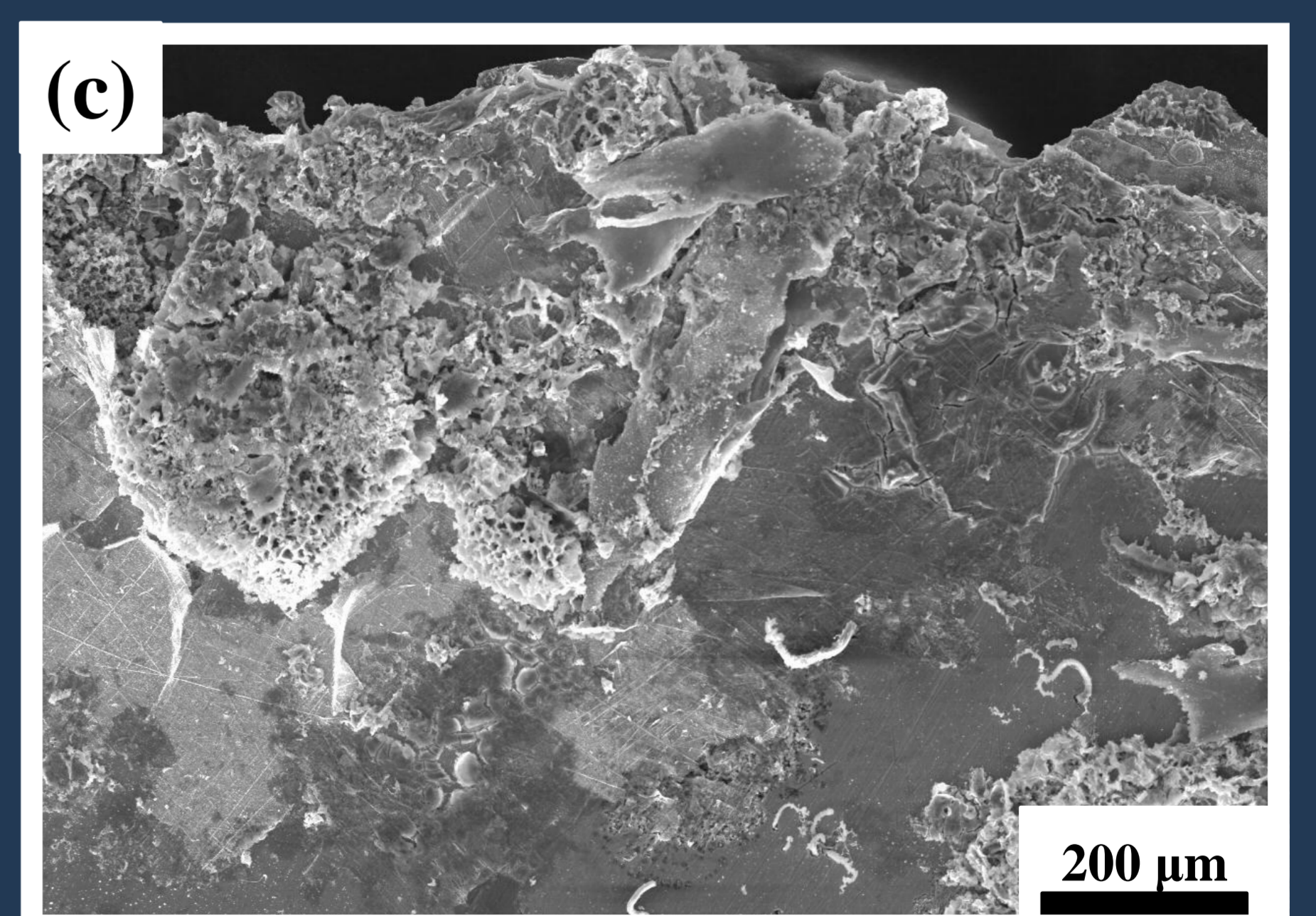
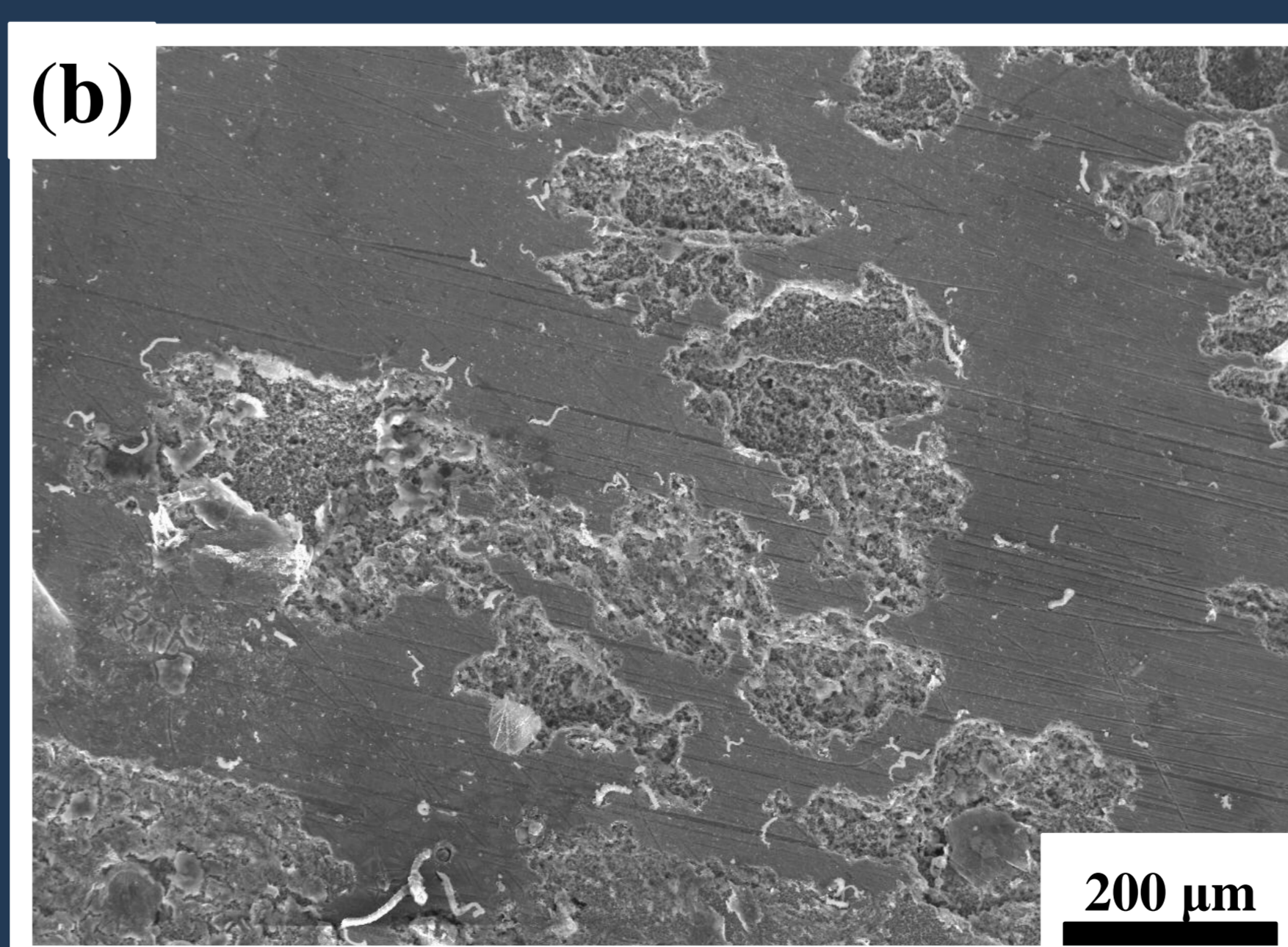
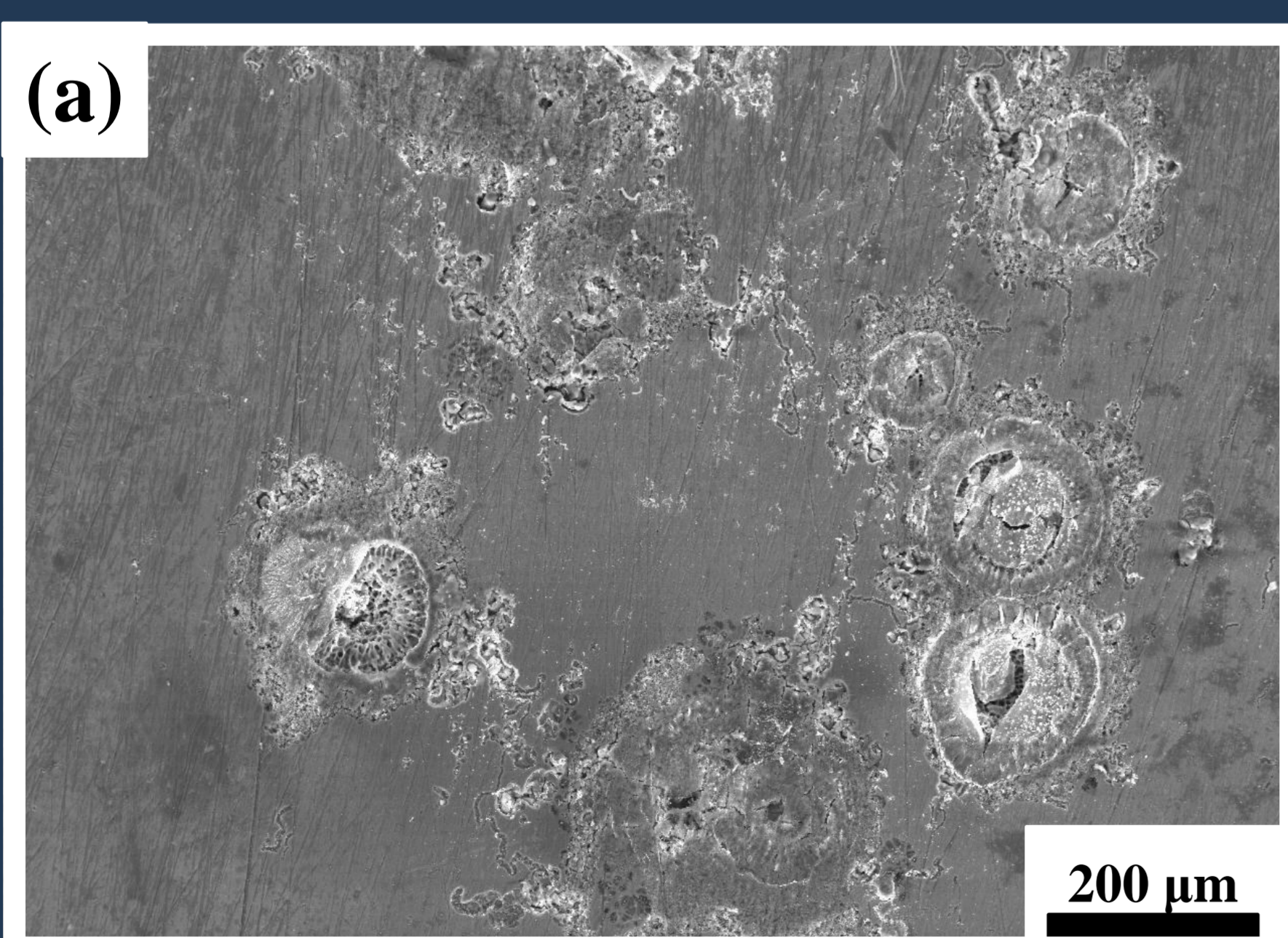


Figure 5 SEM images of (a) as-fabricated  $Zr_{53}Cu_{30}Ni_9Al_8$  metallic glasses and  $Zr_{53}Cu_{30}Ni_9Al_8$  metallic glasses annealed at (b) 712 K and (c) 722 K.

## Conclusions

1. The as-fabricated  $Zr_{53}Cu_{30}Ni_9Al_8$  exhibits lower corrosion current density ( $I_{corr}$ ), higher corrosion current potential ( $E_{corr}$ ), lower spontaneous passive current density, and higher pitting overpotential ( $E_{pit}-E_{corr}$ ) than its partial crystalline alloys.
2. According to the results as mentioned above, the as-fabricated  $Zr_{53}Cu_{30}Ni_9Al_8$  possesses better corrosion resistance, and it is much easier to form the protective passive layer for avoiding the pitting reaction by chloride in SBF.