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BACKGROUND ELECTROLYTES BASED ON NATURAL POLYMER HYDROGELS FOR IN VITRO ELECTROCHEMIACAL TECTING OF MEDICAL MAGNESIUM ALLOYS

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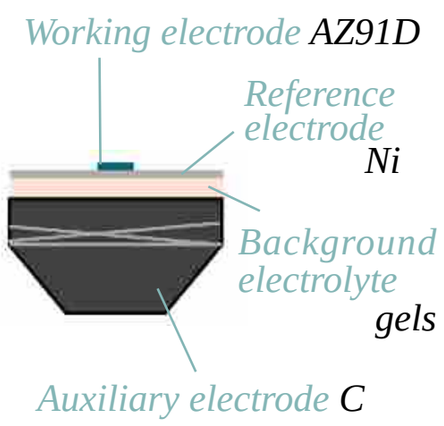
INTRODUCTION

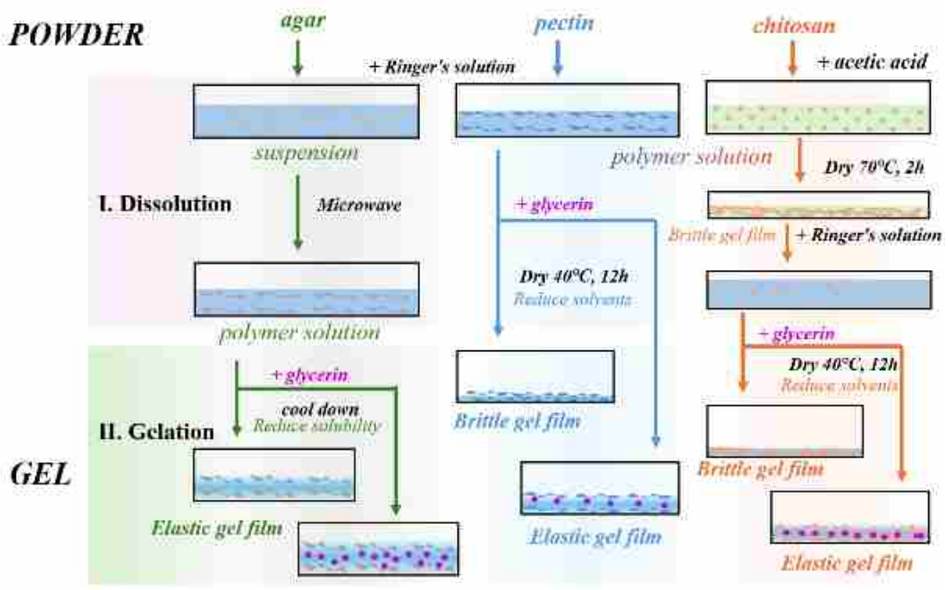
Benefiting from hydrogels derived from plants and animals that exhibit microstructural and elemental composition characteristics highly similar to human tissues and extracellular matrix, this study systematically screened and comparatively evaluated three bio-gel materials (agar, pectin, and chitosan) as simulated physiological electrolyte media for the accurate determination of medical magnesium alloy degradation rates. This approach effectively addresses the significant evaluation errors caused by conventional liquid electrolytes' inability to simulate the complex multiphase microenvironment within the human body.

METHOD

Electrolytic cells for gel electrolytes

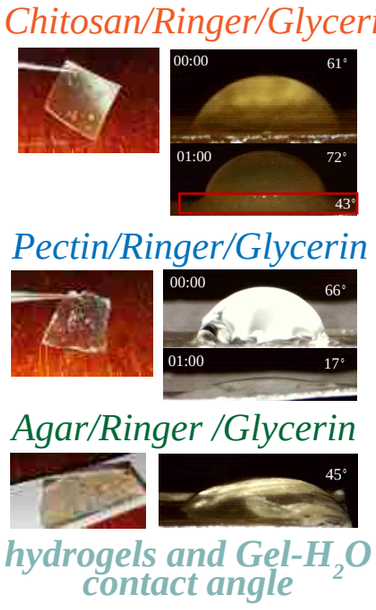


Synthesis of gels

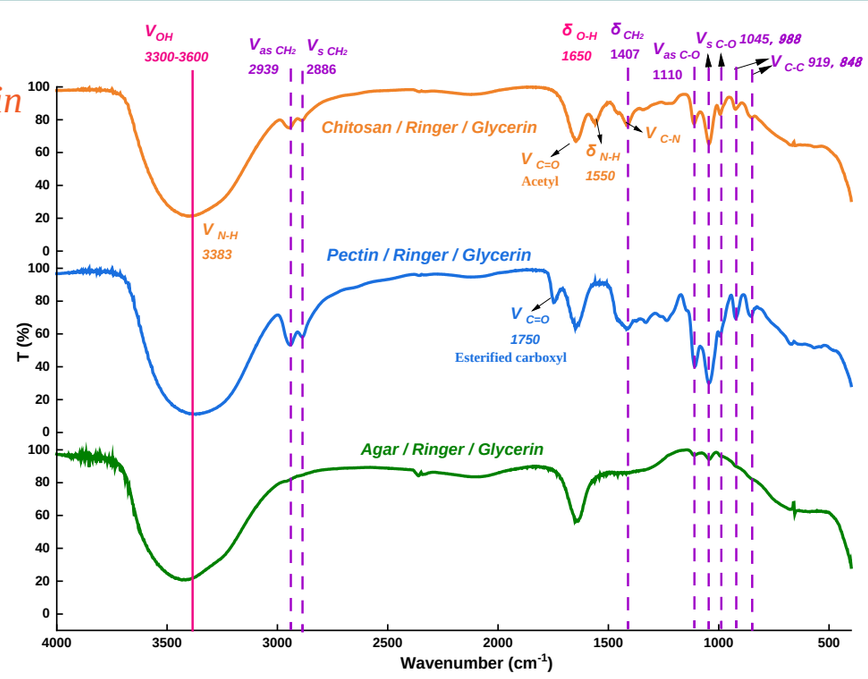


RESULTS

Hydrogels insights

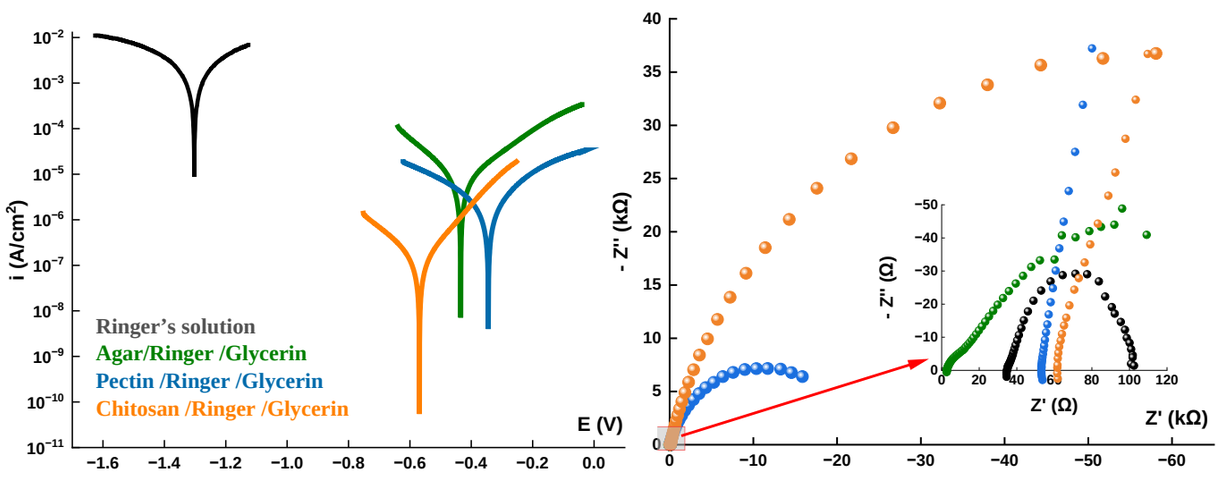


hydrogels and Gel-H_2O contact angle



IR spectra of polymer gels

Electrochemical corrosion assessment

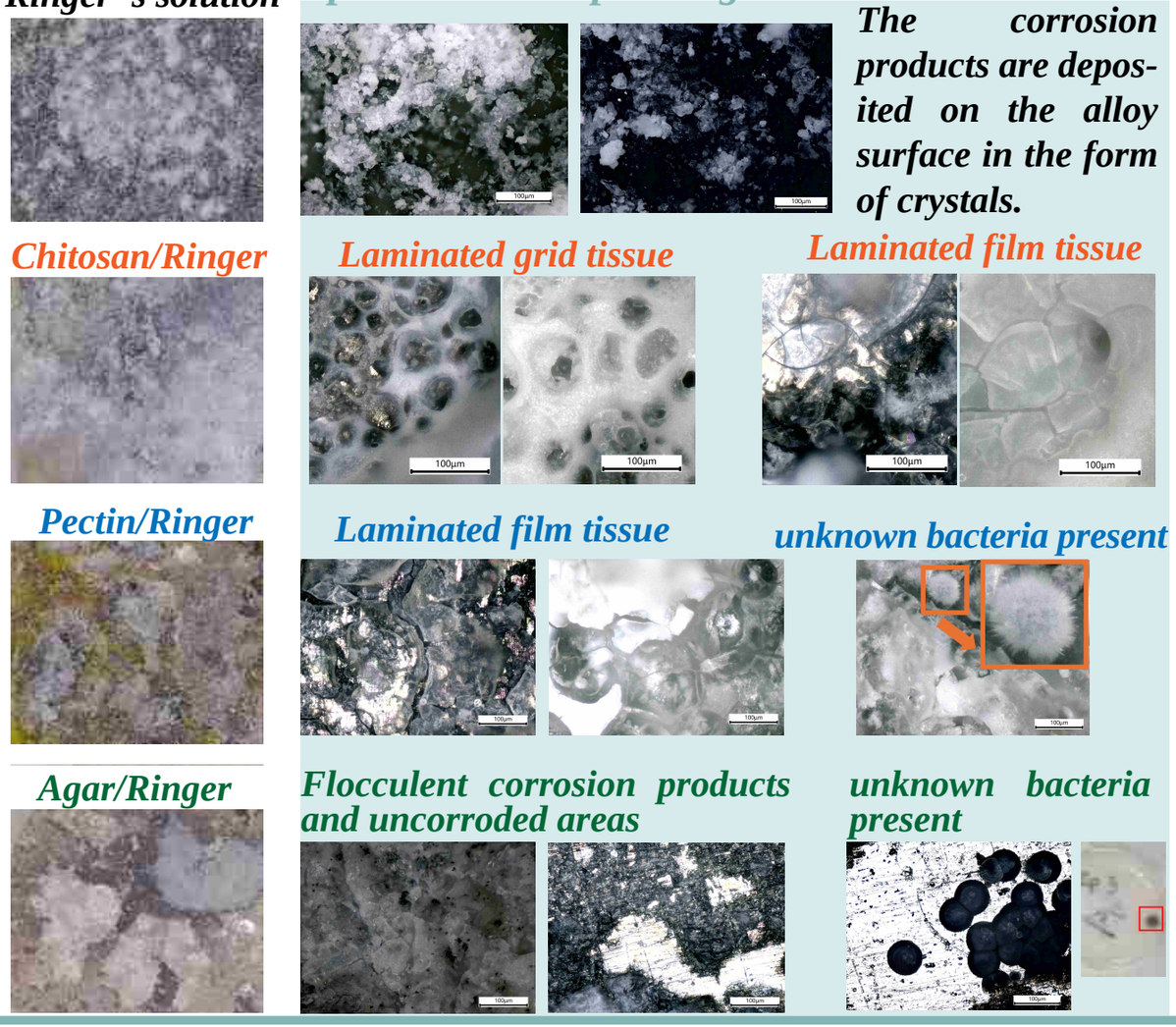


PDP curves and EIS spectra of Mg-Al alloy with solution and gel backround electrolytes.

Background electrolyte	E_{corr}, V	I_{corr}, mA/cm²	Degradation rate, mm/year	R_{ct}, kΩ
Ringer's solution	-1.287	91.213	1.930	0.059
Agar/Ringer /Glycerin	-0.434	9.616	0.203	0.277
Pectin /Ringer /Glycerin	-0.344	2.874	0.006	19.266
Chitosan /Ringer /Glycerin	-0.569	0.147	0.003	100.06
In vitro [Witte F, 2006]	-	-	3.52E-4	-

Witte F, Fischer J, Nellesen J, et al. In vitro and in vivo corrosion measurements of magnesium alloys[J]. Biomaterials, 2006, 27(7): 1013-1018.

Mg-Al alloy contact test



CONCLUSION

1. The surface morphology of the Mg-Al alloy after contact with the ***gel*** is closer to the actual in vivo situation. (The three gels exhibit different transition interface morphology characteristics.)
2. ***Agar*** and ***pectin*** are prone to bacterial growth in a closed environment.
3. The use of gel electrolyte can greatly reduce the difference between the actual in vivo evaluation and the in vitro electrochemical evaluation. (The degradation rate of magnesium alloy in contact with ***chitosan/Ringer/glycerol*** gel is closest to the rate measured in mice.)