

Changes on surface morphology of starch based thermoplastic blends after enzymatic degradation using contact angle measurements

M. A. Araújo^{1,2,3}, A. M. Cunha², M. Mota¹

¹IBB-Institute for Biotechnology and Bioengineering, Centre for Biological Engineering, Universidade do Minho, Campus de Gualtar, Braga 4710-057, Portugal. Email: mmota@deb.uminho.pt

²Escola Superior de Tecnologia e Gestão, IPVC, Avenida Atlântico, Viana do Castelo, 4900-348 Portugal. Email: alberta@estg.ipvc.pt

³Institute for Polymers and Composites - IPC, Universidade do Minho, Campus de Azurém, Guimarães, 4800-058 Portugal. Email: amcunha@dep.uminho.pt

Introduction

Starch-based polymers exhibit a wide range of properties that make them suitable for use in the biomedical field, as bone replacement implants, bone cements, drug delivery systems and tissue engineering scaffolds. Due to their processing versatility, they exhibit a range of mechanical properties analogous to that of natural bone, as well as biocompatible behaviour already demonstrated by *in vitro* (Gomes et al., 2001) and *in vivo* studies. Varying the composition of the synthetic copolymer it is possible to alter the balance between hydrophobic and hydrophilic interactions. All these requirements require the accurate control of the polymer water sensitivity, degradation rate and, consequently, mechanical performance. Previous studies using starch based compounds showed that the starch phase in the compound, being more hydrophilic, enhances the water infiltration process.

The present study is a structural investigation of the surface morphology of blends consisting of starch and a synthetic polymer (EVOH), after enzymatic degradation, using contact angle measurements.

Materials and Methods

A thermoplastic blend of corn starch with a poly(ethylene-vinyl alcohol) copolymer (60/40 mol/mol), SEVA-C was studied. Three different batches were tested using SEVA-C samples of different thickness (0.15 and 0.5 mm) in a Hank's balanced salt solution (HBSS) with α -amylase, at pH 7.4 and $37^\circ\text{C} \pm 1^\circ\text{C}$, up to 90 days. Films of SEVA-C, with the same weight (1.6 g), were used for two batches, corresponding to 10 and 20 times (2 and 4 films) the surface area of the other batch (square plates of $30 \times 30 \times 2 \text{ mm}$ of SEVA-C). Extension of degradation was evaluated using thermogravimetric analysis (TGA), in a Shimadzu 50. Changes on surface morphology of SEVA-C, were followed by contact angle measurements, as function of immersion time (Dataphysics OCA 20).

Results and Discussion

Figure 1 shows the results obtained for contact angle measurements using water, as a function of immersion time. In both cases the contact angle was higher than 50° , SEVA-C surface was considered to be hydrophobic. SEVA-C specimens exhibit a higher hydrophobicity, since the average contact angles are higher than films. This result can be the combined effect of several features: higher surface roughness, less amorphous starch on the outer surface and increase porosity.

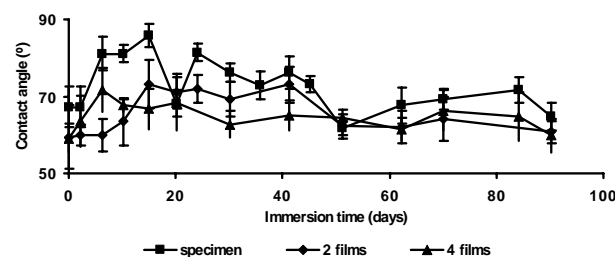
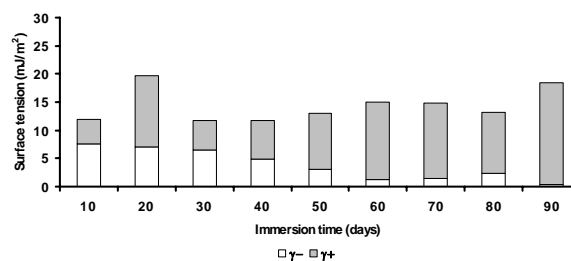


Figure 1 – Contact angle measurements for water on SEVA-C specimen and films, as a function of immersion time.

The surface tension components of SEVA-C specimen

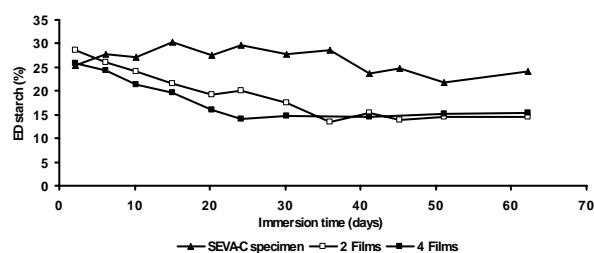


were also quantified as demonstrated on figure 2.

Figure 2 – Surface tension components of SEVA-C surface (in mJ/m^2), for different immersion times.

The values of surface tension revealed the hydrophobic character ($\gamma_s^- \leq 25.5 \text{ mJ/m}^2$), being predominantly electron donating.

Thermogravimetric analysis was also used to quantify the amorphous phase leached to the solution during



degradation.

Figure 3 – Extension of degradation (%) of starch for SEVA-C specimen and films, as a function of immersion time.

SEVA-C specimen has higher starch amount (25%), being less degraded than films. For films, the starch remained on the material was around 10%.

Conclusion

SEVA-C surfaces were hydrophobic, being predominantly electron donating. TGA confirmed the difference of degradation between SEVA-C specimen and films, attributed to the different exposed surface.

References

Gomes, M. E., Reis, R. L., Cunha, A. M., Blitterswijk, C. A., and de Bruijn, J. D. (2001), *Biomaterials*, 22, 1911-1917.

