Investigation of eggshell membrane effect on curing kinetics of epoxy resin system with 100 % bio-based carbon content

K. Novotný[1,a)], M. Feuchter[1,b)], K. Resch-Fauster[1,c)]

[1]*Chair of Materials Science and Testing of Polymers, Montanuniversität Leoben, Leoben, Austria*

a) Kamil.Novotny@unileoben.ac.at
b) Michael.Feuchter@unileoben.ac.at
c) Katharina.Resch-Fauster@unileoben.ac.at

Bio-based epoxy systems have gained significant attention in recent year, primarily due to efforts to replace commercial fossil-based products with greener alternatives derived from renewable resources. Reinhardt et al. have demonstrated a fully bio-based epoxy thermoset based on epoxidized linseed oil (ELSO) and tannic acid, exhibiting a glass transition temperature of 147 °C and a flexular modulus of 2986 MPa, demonstrating competitive mechanical performance relative to traditional petroleum-based products. [1] Using ELSO and citric acid (CA), Anusic et al. prepared a high-performance thermoset with a storage modulus of 1380 MPa. [2] However, the primary limitation of such systems usually resides in long curing times at high temperatures, thus impeding their broader adoption in commercial applications.
Over the past several decades, eggshell (ES) waste has become a significant food industry pollution hazard with an estimated 8 milion metric tons produced anually. [3] Efforts of reducing the environmental impact and improving the sustainability of ES waste via recycling and valorization include production of composite materials, where ES replace traditional non-renewable mineral resources of $CaCO_3$. Recently, chicken eggshell powders were also explored as promising curing catalysts of bisphenol A diglycidyl ether epoxy resins [4] .
The presented work studies the effects of increasing eggshell powder additions in an ELSO resin with CA hardener resulting in a composite with 100 % bio-based carbon content. Curing kinetics of the respective compositions are investigated using differential scanning calorimetry and kinetic parameters are assessed using several isoconversional models. Additionally, the effects of eggshell powder fillers on thermal, thermomechanical and mechanical properties are evaluated.

Keywords: epoxy, bio-based, eggshell membrane, curing kinetics

Acknowledgments

This study was performed within the COMET-project bio-ART which is funded within COMET – Competence Centers for Excellent Technologies – by BMK, BMAW as well as the co-financing federal province Styria. The COMET programme is managed by FFG. www.ffg.at/comet

References

ADDIN CitaviBibliography[1] N. Reinhardt, J. M. Breitsameter, K. Drechsler, B. Rieger, Macro Materials & Eng 2022, 307.
[2] A. Anusic, Y. Blößl, G. Oreski, K. Resch-Fauster, *Polymer Degradation and Stability* **2020**, *181*, 109284.
[3] B. M. Babalola, L. D. Wilson, *J. Compos. Sci.* **2024**, *8*, 414.
[4] J. J. P. Barros, N. G. Jaques, I. D. d. S. Silva, A. K. C. de Albuquerque, A. M. Araújo, R. M. R. Wellen, *Polímeros* **2022**, *32*.