# Cyclic carbonates as safe and versatile etherifying agents for the functionalization of lignins and tannins

Antoine Duval, Luc Avérous*

*BioTeam/ICPEES-ECPM, UMR CNRS 7515, Université de Strasbourg, 25 rue Becquerel, 67087 Strasbourg Cedex 2, France*

* Corresponding author: Prof. Luc Avérous, Phone: + 333 68852784, Fax: + 333 68852716, E-mail: luc.averous@unistra.fr

# Electronic Supplementary Information

*14 pages, 23 Figures and 2 Schemes.*

# Additional Figures

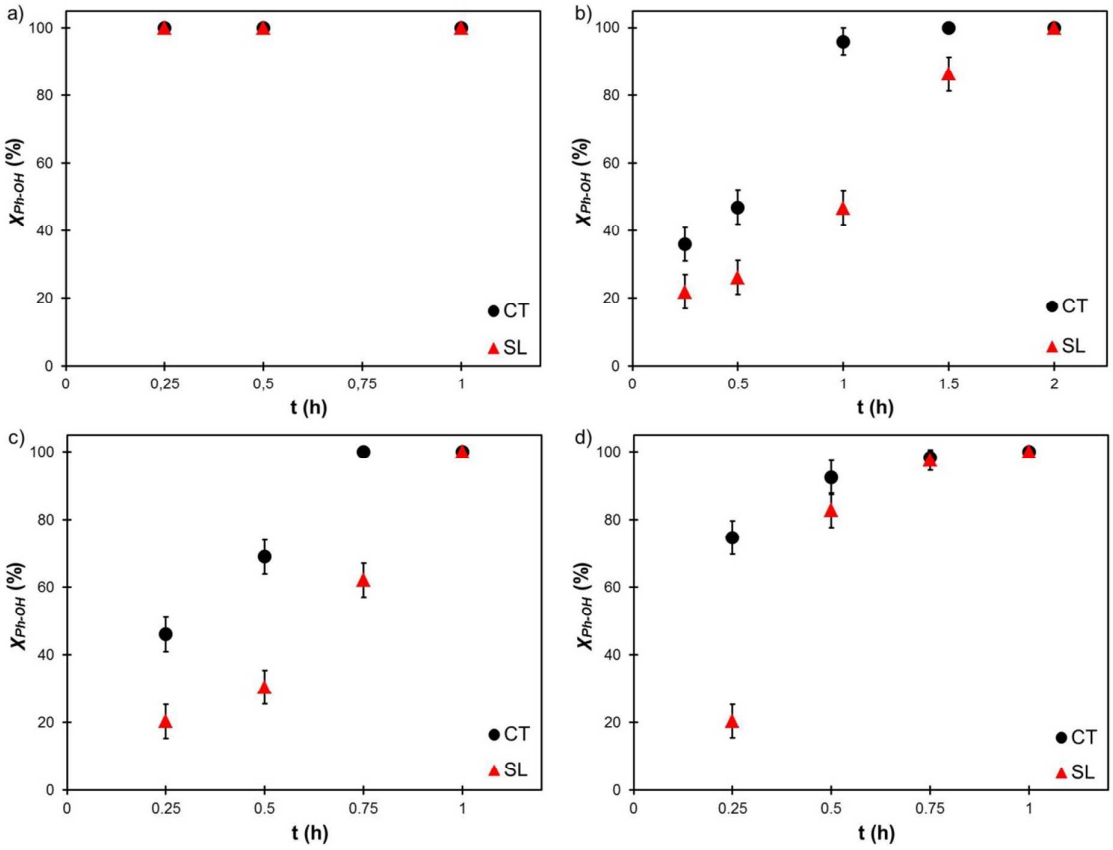



**Figure S1.** Evolution of the conversion of phenol groups ($\chi_{Ph\text{-}OH}$) of CT and SL during reactions with EC (a), PC (b), GC (c) and VEC (d).

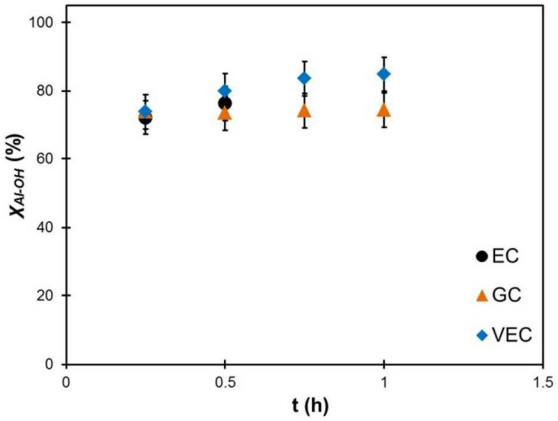



**Figure S2.** Evolution of the conversion of the aliphatic OH groups ($\chi_{Al\text{-}OH}$) of CT during the reaction with EC, GC and VEC.

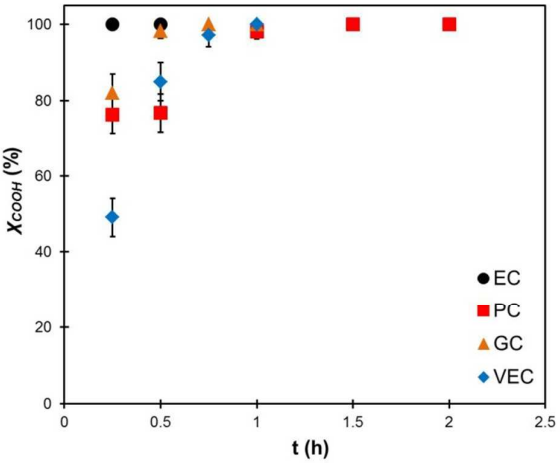



**Figure S3.** Evolution of the conversion of the carboxyl groups ($\chi_{COOH}$) of SL during the reaction with EC, PC, GC and VEC.

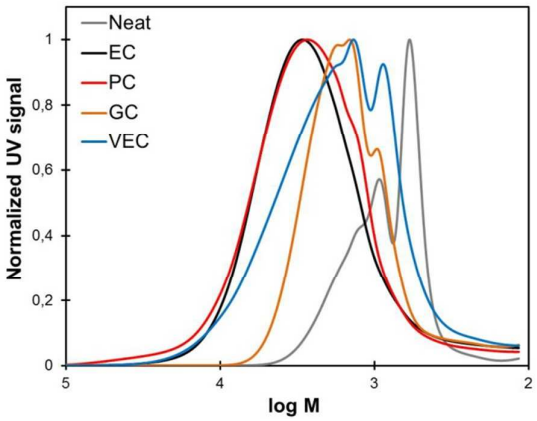



**Figure S4.** SEC traces of the CT derivatives obtained with the different cyclic carbonates. Acetylated samples in THF, PS calibration.

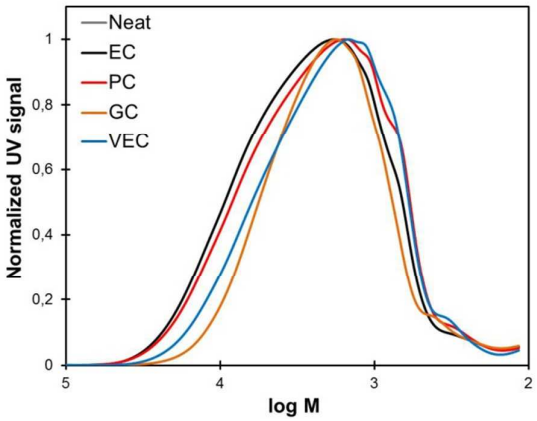



**Figure S5.** SEC traces of the SL derivatives obtained with the different cyclic carbonates. Acetylated samples in THF, PS calibration.

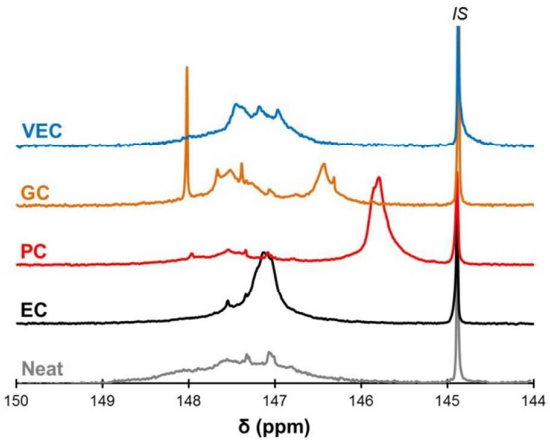



**Figure S6.** Detail of the aliphatic OH region of the $^{31}$P NMR spectra of SL derivatives obtained with the different cyclic carbonates. *IS* = internal standard (cholesterol).

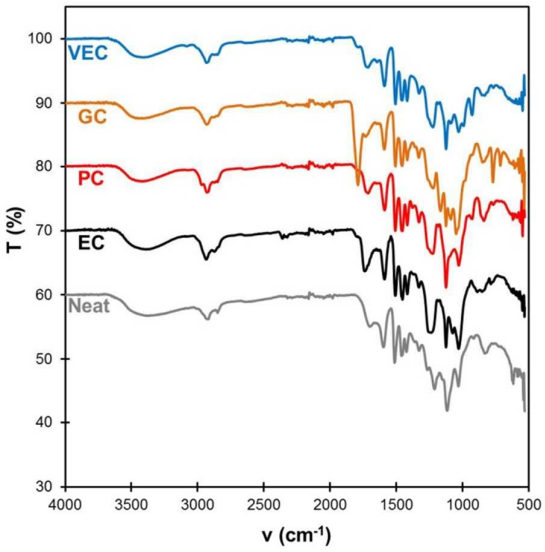



**Figure S7.** FTIR spectra of SL modified with the different cyclic carbonates.

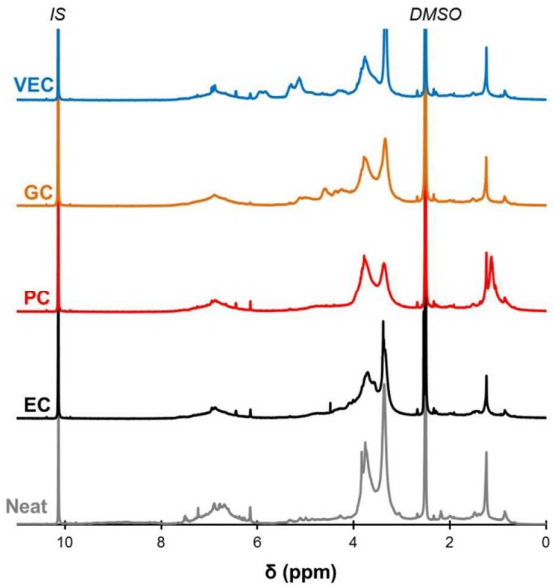



**Figure S8.** $^{1}$H NMR spectra of SL modified with the different cyclic carbonates.

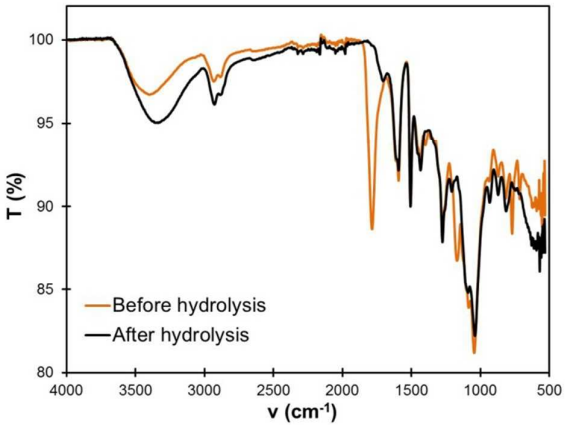



**Figure S9.** FTIR spectra of the CT derivative obtained with GC before and after hydrolysis.

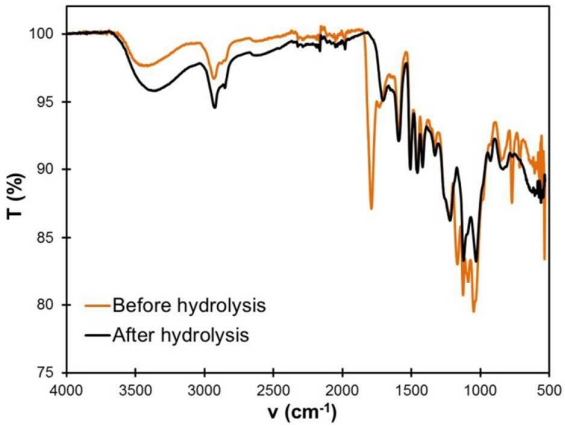



**Figure S10.** FTIR spectra of the SL derivative obtained with GC before and after hydrolysis.

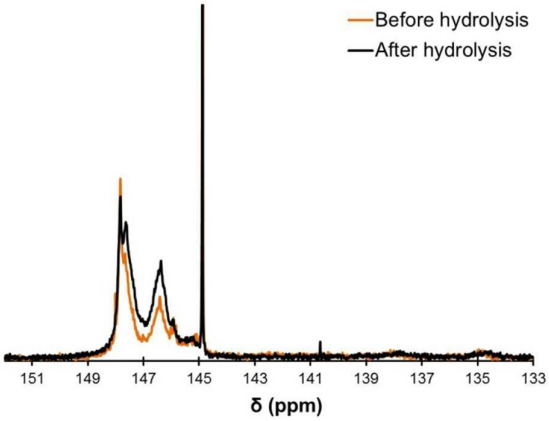



**Figure S11.** $^{31}$P NMR spectra of the CT derivative obtained with GC before and after hydrolysis.

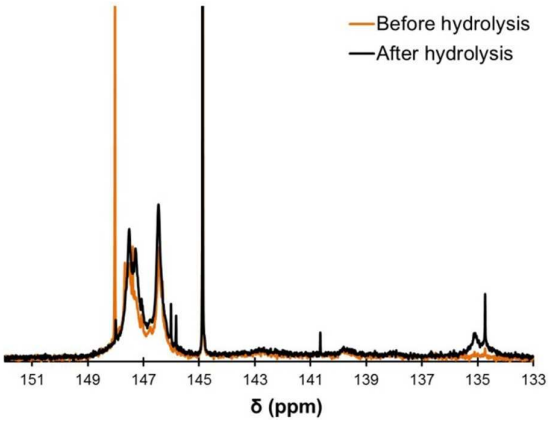



**Figure S12.** $^{31}$P NMR spectra of the SL derivative obtained with GC before and after hydrolysis.

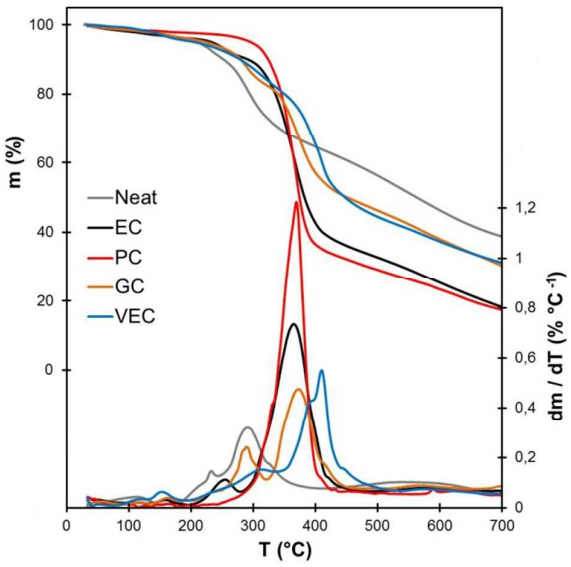



**Figure S13.** Thermogravimetric analysis of CT derivatives obtained with the different cyclic carbonates.

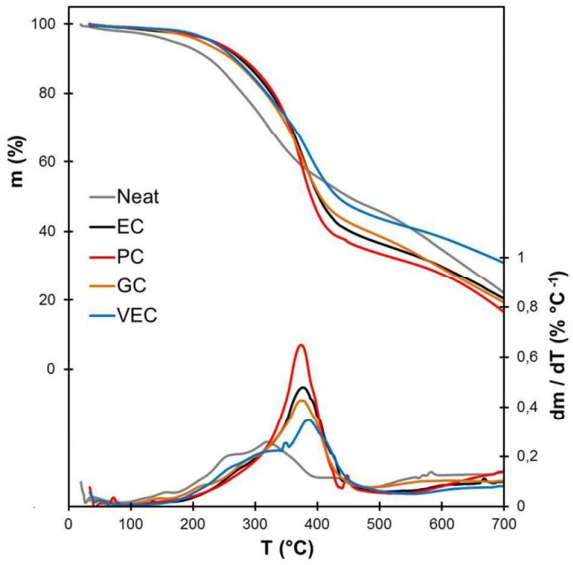



**Figure S14.** Thermogravimetric analysis of SL derivatives obtained with the different cyclic carbonates.

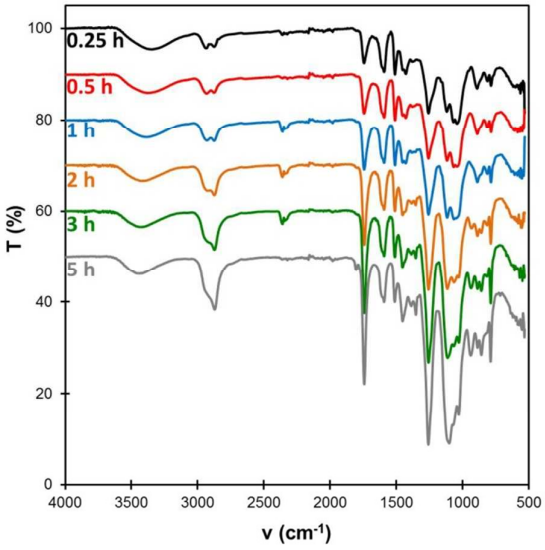



**Figure S15.** FTIR spectra of CT reacted with EC for increasing reaction times.

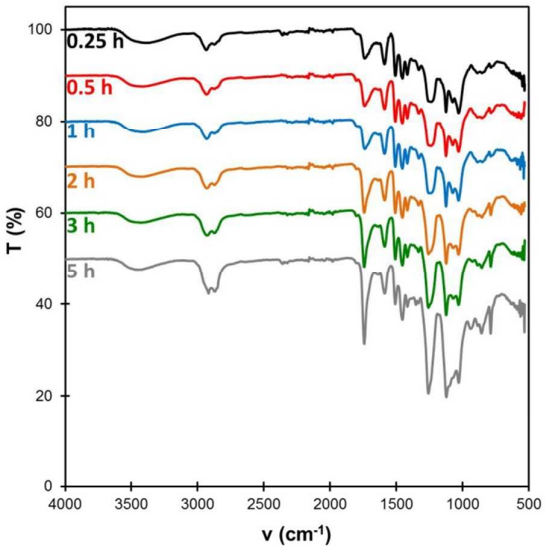



**Figure S16.** FTIR spectra of SL reacted with EC for increasing reaction times.

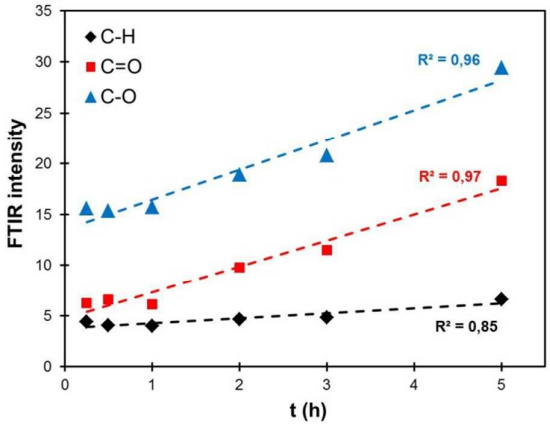



**Figure S17.** Evolution of the intensities of the FTIR peaks of C-H (2933 $cm^{-1}$), C=O (1740 $cm^{-1}$) and C-O (1257 $cm^{-1}$) stretches with the reaction time during the reaction between SL and EC.

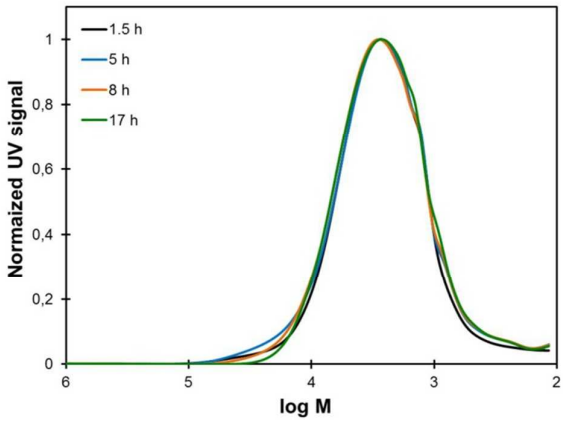



**Figure S18.** SEC traces of the CT derivatives obtained after various reaction times with PC.

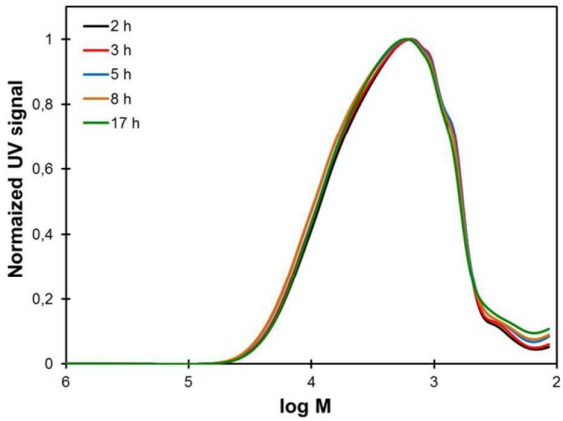



**Figure S19.** SEC traces of the SL derivatives obtained after various reaction times with PC.

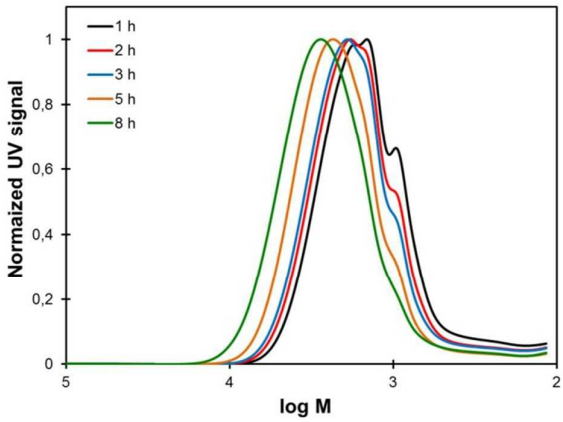



**Figure S20.** SEC traces of the CT derivatives obtained after various reaction times with GC.

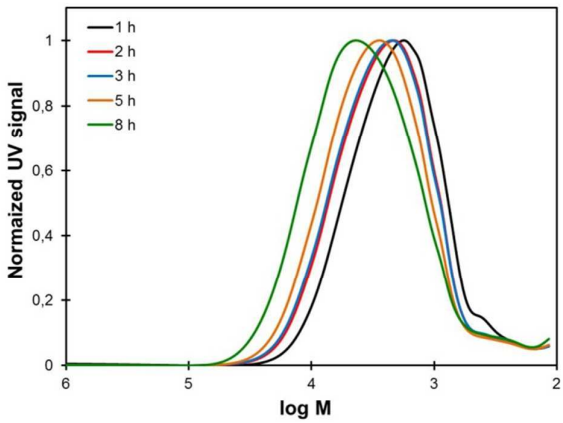



**Figure S21.** SEC traces of the SL derivatives obtained after various reaction times with GC.

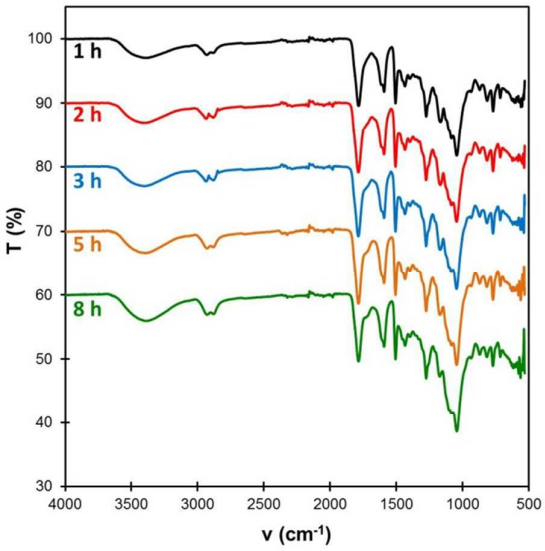



**Figure S22.** FTIR spectra of CT reacted with GC for increasing reaction times.

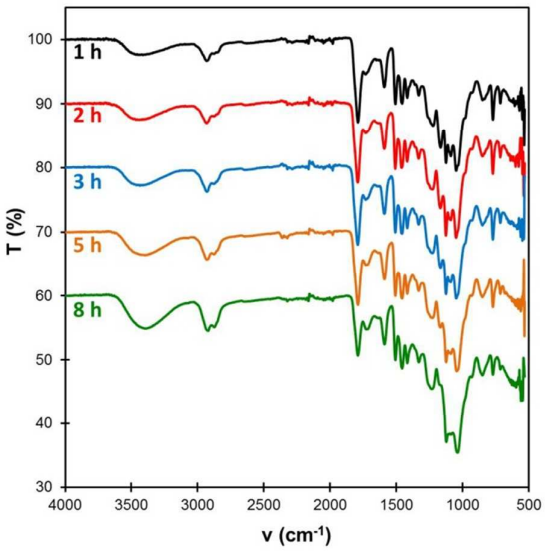
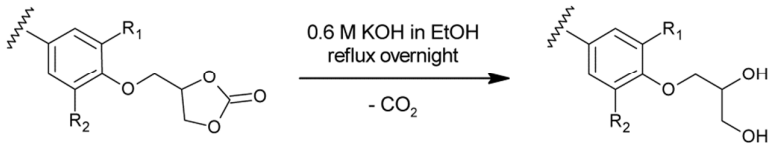



**Figure S23.** FTIR spectra of SL reacted with GC for increasing reaction times.

# Additional reaction schemes




**Scheme S1.** Hydrolysis of the 5-membered cyclic carbonates present on the derivatives prepared with GC.


**Scheme S2.** Chain coupling by transesterification, leading to crosslinking during the reaction with EC for extended reaction time.